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ACUTE HEMATOGENOUS OSTEOMYELITIS

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In view of the fact that an early diagnosis is rarely made in cases of acute osteomyelitis, and that the recognized textbook treatment of this condition in the early stage is open to question, it seems desirable that the subject should be reviewed and the experience of a large hospital clinic placed before the surgical public.

The condition which we call osteomyelitis is essentially an inflammation of all the structures of the bone, and really should be designated a periosteomyelitis. It seems incredible that an acute infection could be limited to the cancellous bone or to the periosteum, in view of the easy access and free communication between these by means of the haversian canals and para-epiphyseal line.

ANATOMIC CONSIDERATIONS

It is necessary in studying this problem to remember some of the anatomic features as they relate to bone growth and development. The circulation of an ordinary long bone, as described by Lexer, is derived from three sources:

The nutrient artery enters the shaft at about its middle and divides, sending branches to either extremity, which, after numerous divisions, end in fine capillaries near the juxta-epiphyseal line or metaphysis.

The epiphysis gets its blood supply from the cortical branches, which find their way in from the cortex along the epiphyseal line and are distributed to the whole of the epiphysis.

The cortex of the entire shaft receives its nutrition from the periosteal vessels.

The epiphysis in each long bone is, in most cases, not united by bone until early in adult life. The growth takes place on the diaphyseal side of the growing line, as can be demonstrated by an attempt to separate the epiphysis.

By forcibly tearing off the epiphysis from the shaft in the growing bone, it is seen that the separation takes place at the diaphyseal side of the epiphyseal line, and leaves an irregular series of indentations. In the child, the periosteum continued down from the shaft dips into the epiphyseal line and becomes densely adherent at this point. This condition prevents, in most cases, direct extension of infection to the joint.

ETIOLOGY

Osteomyelitis is practically always a blood-borne infection from a primary focus situated elsewhere in the body. This primary focus may be the tonsils or mouth cavity, but much more frequently some local infection of the skin, as boils or infected wounds and cellulitis. The commonest type of organism is *Staphylococcus aureus* and some strains of the streptococci.



Fig. 1.—Drawing from photomicrograph, showing usual type of bone inflammation.

The blood stream infection is most frequently transient and cultures may be obtained but rarely. When the blood culture is positive and repeated, a general septicemia results, and recovery is uncommon.

The element of trauma must play a part in determining the seat of invasion. When one remembers that it is possible to wrench an epiphysis in a growing child sufficiently to produce pain or even hemorrhage into the line of growth, it is easily seen that the resistance will be low-

ered at this point, and a good culture medium provided as well. Hence it is probable that an injury may be the determining factor in localizing the site of invasion.

In our experience, the bones primarily affected are, in order of frequency, the upper end of the tibia, the lower end of the femur, the lower end of the tibia and fibula, the lower end of the humerus, the upper end of the femur, the lower end of the radius, and then the ulna, the bones of the tarsus, the crest of the ilium and scapula, in that order.

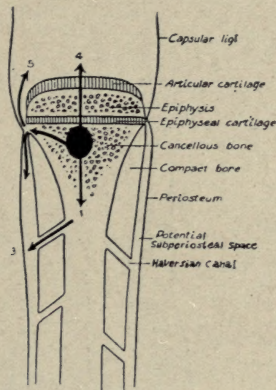


Fig. 2.—Schematic representation of a long bone, showing direction of possible spread of infection from the metaphysis (para-epiphyseal or juxta-epiphyseal region). (From Choyce, System of Surgery.)

These findings strengthen the view that trauma is a distinct factor in the disease, as it is noted that they show a greater percentage of invasion at the points most subject to injury. The lower extremity shows a higher percentage than the upper, and the neighborhood of the knee the greatest of the lower extremity.

AGE

Acute osteomyelitis is essentially a disease of childhood. It occurs at this period because the actively growing bone is less resistant to infection than adult tissue, and because trauma at the epiphysis is possible only at this age.

It is extremely rare to find osteomyelitis in the adult, aside from that due to direct injury to bone and primary infection, such as is found in compound fractures and bullet wounds. The commonest age is from 2 to 10 years.

SEX

Boys are slightly more frequently affected than girls, possibly owing to increased opportunity of injury.

PATHOLOGY

It is obvious that a true conception of the pathology of this condition must be built up, as upon this the treatment to be adopted neces-



Fig. 3.—Necropsy specimen, showing early focus of infection in the tibia.

sarily depends. Our experience does not entirely correspond to the average textbook teaching, hence it is presented in more detail than might seem essential.

The offending organisms are carried through the blood stream to reach the finer capillaries in the juxta-epiphyseal region of a long bone.

If the general resistance of the individual is lowered by ill health, and the local resistance is lowered by trauma, the infective process is started, and a small inflammatory area in the cancellous bone near the epiphyseal line results. This area shows the usual type of bone inflammation, as is illustrated by Figure 1.

The commonly accepted view is that from this focus the infection spreads with greatest rapidity through the cancellous bone to the medullary canal, and in a few brief hours may involve the whole

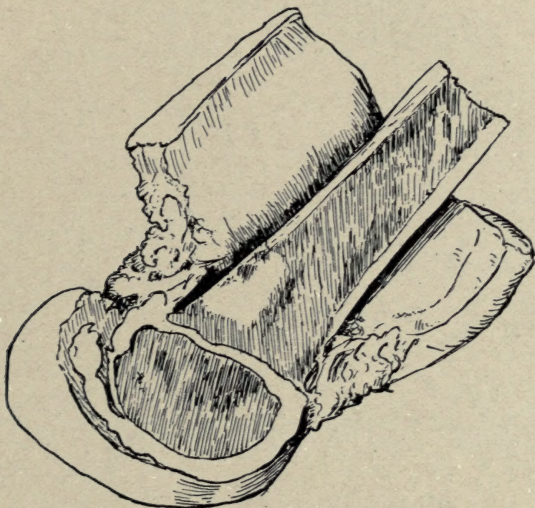


Fig. 4.—Necropsy specimen, showing early infection with inflammatory changes, marked at the periosteum and epiphyseal line.

interior of the shaft. Then it is said to spread outward through the haversian canals to the periosteum, and to undermine this structure. That it may spread downward through the epiphysis, and at times under the capsule of the joint, where it invades the joint, is also generally accepted.

Figure 2, taken from Choyce's System of Surgery, illustrates the commonly accepted view of the spread of infection. It is noted in the diagram that the chief spread is through the cancellous tissue into the medullary canal. In the text it is stated that "infection tends to spread through the cancellous tissue into the medulla, and perhaps also down under the periosteum."

In our experience, the focus of infection located in the metaphysis spreads fairly rapidly along the line of the epiphysis to reach the periosteum. Frank pus is here formed, and the infection spreads rapidly under the periosteum, stripping this structure from the bone surface. It spreads less rapidly through the cancellous tissue to the medullary canal, and the medullary canal is more frequently invaded through the haversian canals, secondarily to the periosteal infection.

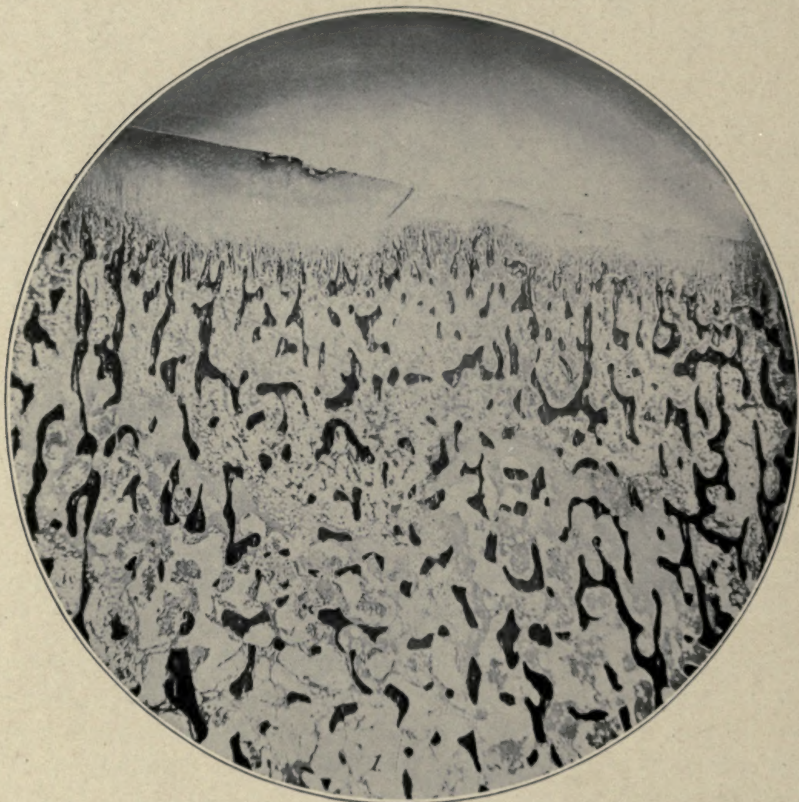


Fig. 5.—Photomicrograph of section from specimen shown in Figure 4.

This seems to be susceptible of demonstration by necropsy specimens which have been recovered from patients dying early of general septicemia, from roentgen-ray findings of the cases seen at all stages, and from animal experiments.

The tibia shown in Figure 3 was recovered at necropsy from a child, aged 2 years, who died of septicemia forty-eight hours after the onset of symptoms. It is readily noted in the specimen that the focus of infection is just above the lower epiphyseal line, and of comparatively small extent. The gross appearance shows the inflammatory area localized in this region. The microscopic section shows large colonies of cocci in the same area, with marked infiltration of the cancel-

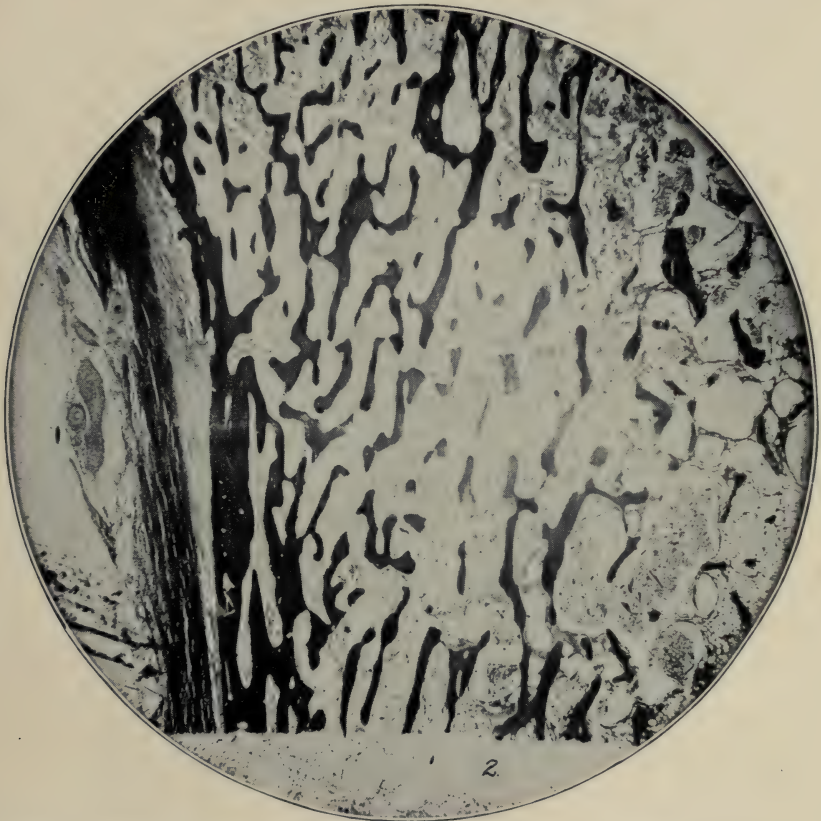


Fig. 6.—Photomicrograph of section from specimen shown in Figure 4.

lous tissue by large mononuclear leukocytes, and already some degeneration showing areas of necrosis. Higher up the shaft and in the medullary canal, there is no gross appearance of inflammation, and the sections show no organisms or evidence of inflammatory change.

The periosteum shows intensive infiltration in the neighborhood of this focus, and, as shown in the illustration, is stripped completely from one epiphysis to the other and for nearly half the circumference of the shaft. There is marked inflammatory change throughout the whole area of the stripped periosteum.

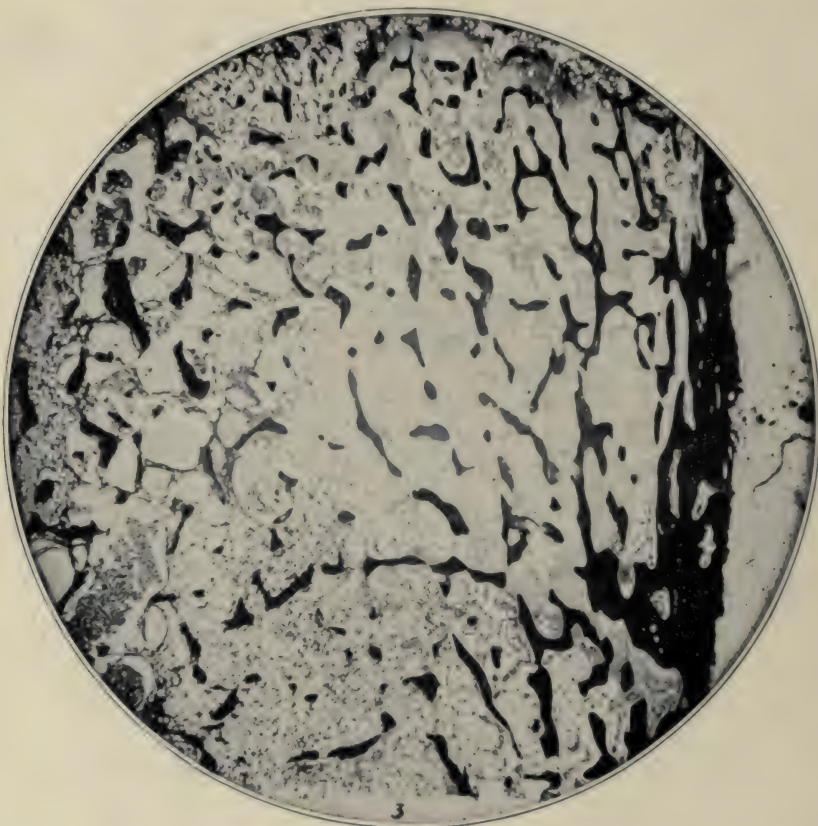


Fig. 7.—Photomicrograph of section from specimen shown in Figure 4.

The culture from this pus showed a hemolytic streptococcus, and a culture from the blood of the patient before and after death showed the same organism.

The specimen shown in Figure 4 was obtained at necropsy from an older child who died, on the third day after the onset of symptoms, of acute septicemia. This shows even more characteristically the points

brought out in Figure 3, but the periosteal stripping is not so extensive. The gross appearance shows an irregular area of gray necrosis, surrounded by dense infiltration of the cancellous tissue and an extension to the periosteum, with periosteal stripping for about 3 inches (7.6 cm.) up the shaft, and about two-thirds around the circumference of the shaft.

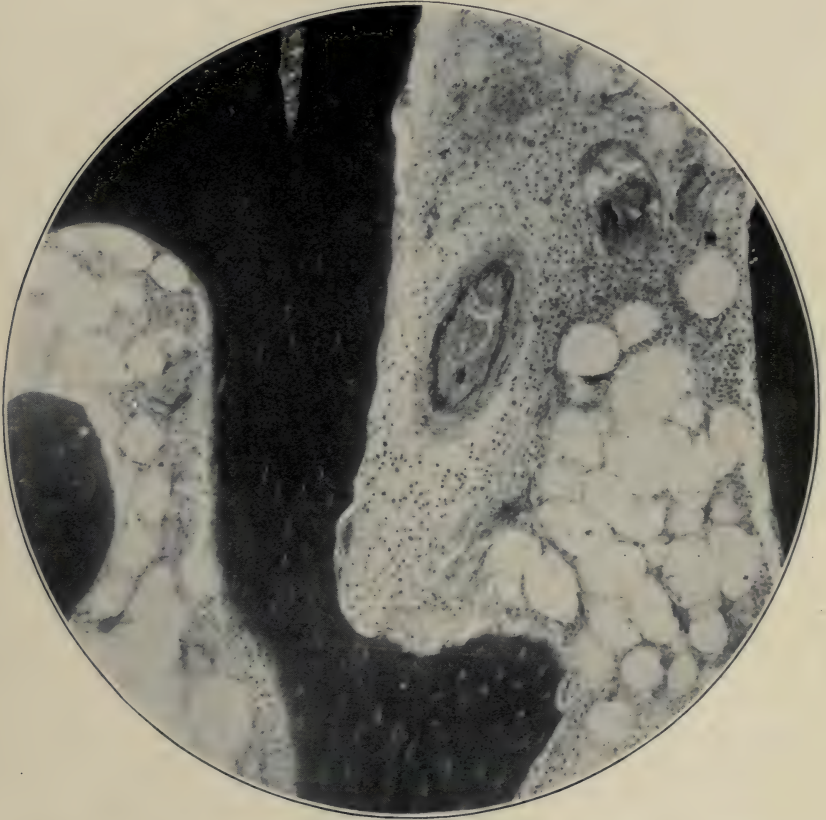


Fig. 8.—Photomicrograph of section from specimen shown in Figure 4.

Figure 1, and the microscopic sections, present the microscopic appearance of this specimen and show a marked inflammatory process in the cancellous portion of the bone, concentrated and apparently most acute at the epiphyseal line. There are large colonies of cocci, with marked infiltration of the cancellous bone with large mononuclear leu-

kocytes. Many of these have degenerated, leaving masses of necrotic material. There are large numbers of giant cells or osteoclasts in this area, which have dissolved the bone salts and left little depressions.

The inflammatory exudate extends outward, and involves the periosteum on each side, showing diffuse and focal areas of infiltration with these large mononuclear cells. In the periosteal area, there is a moderate endarteritis, and some of the lymphatics are filled with cocci. Small areas, as indicated in the illustration by rings, show varying concentration of inflammation, greatest at the epiphyseal line and along the periosteal margins, as shown in Figures 5, 6, 7, 8, 9, 10, 11 and 12.

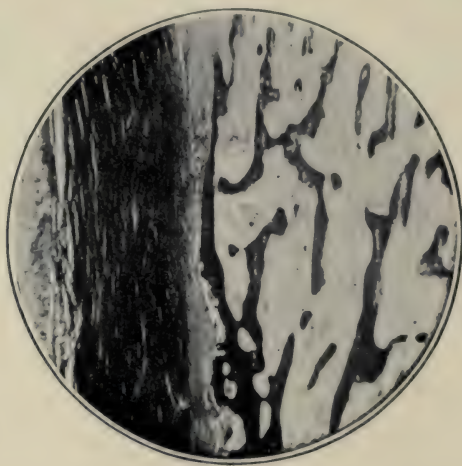


Fig. 9.—Photomicrograph of section from specimen shown in Figure 4.

Figure 13, taken at the highest point of the cancellous tissue, near the center and approximating the medullary canal, is shown free from inflammatory exudate.

ROENTGEN-RAY FINDINGS

There are several facts of importance in the study of the roentgenograms.

1. Roentgen-ray findings are always negative in the early stages. It is not until gross destruction of cancellous bone has taken place, or until new bone begins to develop as an involucrum, that the roentgenograms reveal any definite picture. This is too late to be of any diagnostic value, and it should be emphasized here that roentgen-ray findings should not be waited for in making a diagnosis.

Figure 14, taken six days after the onset, shows only a slight change in density on the diaphyseal side of the epiphysis. The physician in charge of the patient had two roentgenograms made previous to this one, and no bony change was reported. On admission, on the same day that the accompanying roentgenogram (Fig. 14) was made, incision demonstrated pus in fairly large quantity under the periosteum, firm attachment of the periosteum at the epiphyseal line, and the periosteum stripped nearly to the upper end of the shaft.

Figure 15, taken six months later, shows the amount of the destruction of the shaft.

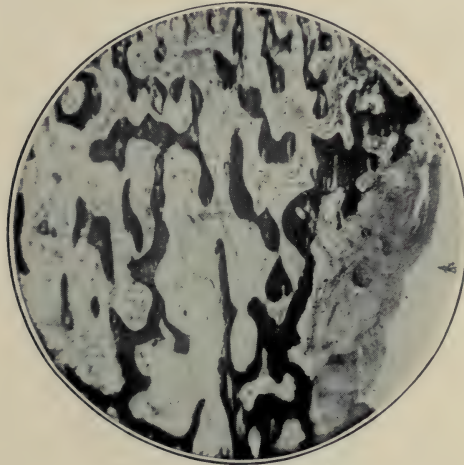


Fig. 10.—Photomicrograph of section from specimen shown in Figure 4.

2. Roentgenograms of cases of osteomyelitis which have been opened through the periosteum even moderately early, all show a fairly similar picture. The bone changes always extend farther up the shaft on the periosteal side than in the medullary area, and for the most part the periosteum is stripped higher on one side than on the other, and consequently, the destroyed part is wedge-shaped, with the base at the epiphysis and the apex on one side of the shaft.

Figure 16 shows a much greater advance of the disease along the cortical area than in the medullary area. This roentgenogram was taken one month after onset, and the physician had evacuated pus from under the periosteum on the seventh day. The relief of tension under

the periosteum had at once limited the extension of the disease both in the medullary area and under the periosteum.

3. Roentgenograms of still later cases, when the tension of pus under the periosteum has not been relieved, show a characteristic "spotty" infection, as if the organisms had been poured through the cortex at various places. This is well shown in Figure 15, where the periosteum was not incised until nearly entirely stripped.

Figure 17 was taken six months after the onset, during which time no treatment had been instituted, but the abscess had been allowed to burst. This also shows the spotty character of the infected bone, as well as areas of shaft and medulla which appear quite normal.

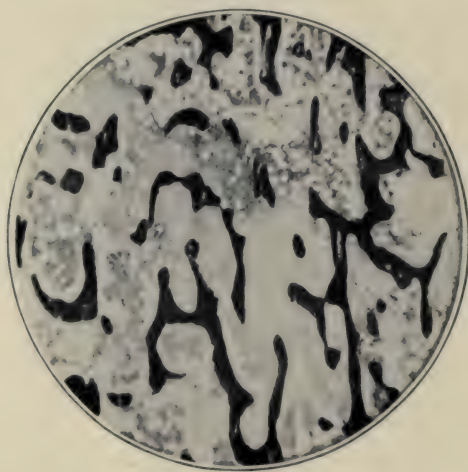


Fig. 11.—Photomicrograph of section from specimen shown in Figure 4.

ANIMAL EXPERIMENTATION

At first in our experimental work, which has been carried on largely by Dr. R. I. Harris, we found great difficulty in producing osteomyelitis in the dog, even with staphylococci or streptococci of known virulence in man. Therefore, our earlier demonstrations were chemically produced with croton oil, sealed with agar and planted in the bone near the epiphysis, as employed by Bancroft and Clarke. These experiments succeeded in demonstrating the process of destruction and sequestration, but were not satisfactory as proof of the spread

of infection. It was found that by tying off the appendix and its mesentery in the dog a general peritonitis is produced. The organisms from this infection if injected into a nutrient artery or into the traumatized metaphysis will produce an acute osteomyelitis in the growing dog. In every case the dog has died within forty-eight hours, but the osteomyelitis is characteristic. The periosteum is rapidly stripped, with findings similar to the sections shown.

No dogs lived long enough to allow the production of later changes and sequestration; but it is quite apparent that the early changes are in the nature of an inflammatory condition along the epiphyseal line, with rapid extension to the cortex, and frank pus under the periosteum.



Fig. 12.—Photomicrograph of section from specimen shown in Figure 4.

From the foregoing presentation of early pathologic changes shown from human necropsy specimens, from the roentgen-ray findings of cases of longer standing, and some of late cases, and from the correspondence of the findings in the animal experiments, it seems reasonable to conclude that, for the most part, infection starts in the metaphysis or diaphyseal side of the epiphyseal line; that it extends most easily along the epiphyseal line to the cortex and the periosteum; that it readily and early strips the periosteum, with increasing tension as more pus is formed; that with increased tension the infection

probably spreads backward through the haversian canals at various levels, and invades the medulla from the cortex, giving this spotty character to the shaft infection.

One should feel that the firm attachment of the periosteum is a safeguard to direct extension to the joint by this route. It is also most unlikely that infection will travel through the epiphysis and articular cartilage direct to the joint.

The neighboring joint is, no doubt, involved in a small number of cases; but I am beginning to believe that it is more often infected secondary to operation, than as a result of primary extension.

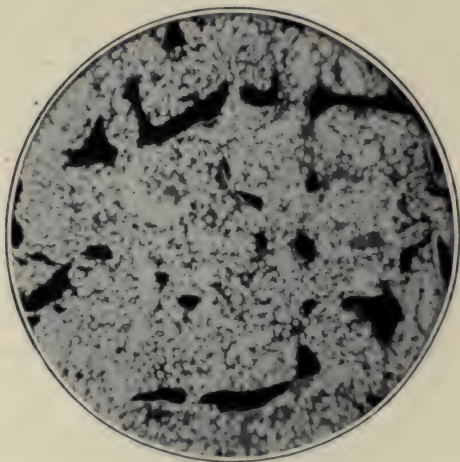


Fig. 13.—Photomicrograph of section of cancellous bone near medullary canal (Fig. 4).

That a serous synovitis occurs from adjacent infection, and consequent hyperemia of the synovial membrane, is unquestioned; but these will usually subside without aspiration or incision.

The changes occurring in the later stages are so well known that they need no elaboration. The formation of a bony wall or involucrum on the under surface of the periosteum, the sinuses passing through this bony covering, the gradual separation of the necrotic area or sequestrum by a layer of granulation tissue forming between the living and dead areas, are conditions which are well described in most textbooks.



Fig. 14.—Roentgenogram taken on the sixth day after onset, showing no bony change.

SIGNS AND SYMPTOMS

Following a fall or moderate injury, there is complaint of pain, severe, of sudden onset, and located in the neighborhood of a joint. This may be preceded a few days by a sore throat or a discharging ear, or some other primary source of infection may be found. Accompanying the pain, there will be tenderness over a limited area, and most extreme at that point. There will be signs of toxemia, headache, dry tongue, sometimes vomiting, with a pulse rate as high as 120 or 130, a temperature of 103 or 104 F., and a marked leukocytosis as high as 25,000 or 30,000. If left alone, later symptoms of redness, swelling, and marked edema develop. With these there is a corresponding increase in the toxic symptoms.

DIAGNOSIS

The diagnosis must be made on the signs present. Severe pain in the neighborhood of a joint, with a spot of extreme tenderness, in a growing child is extremely significant. If it is accompanied by high fever and rapid pulse, with high blood count, the diagnosis is moderately certain.

It is so essential that an early diagnosis be made, that one should be constantly on guard. The roentgen ray is of no assistance in early diagnosis. Valuable time is consumed, which means more and more bone destruction. Salicylates should not be administered if time is lost thereby.

In rheumatism the onset is not usually so severe, nor the pain so excruciating. There is no sharp point of localized tenderness, and the pain is articular, not in the neighborhood of the joint. There is almost immediate swelling of the joint in rheumatism.

An infectious arthritis is sometimes confusing; but the joint manifestations are usually sufficient to differentiate this condition. There is muscle spasm, limited movement of the joint, and early swelling of the synovial pouch. In osteomyelitis the joint is usually free of swelling, and movements are free if gently attempted. Do not wait for signs of swelling, redness and edema, as these are rather later signs. Of course, if these are present when the patient is first seen, they render the diagnosis still more certain.

TREATMENT

The diagnosis being made early, treatment should consist of incision over the area of greater tenderness, through the skin, subcutaneous



Fig. 15.—Roentgenogram of same case as that shown in Figure 14, six months later.

tissue and periosteum to the bone. Care should be exercised to keep the incision clearly on the diaphyseal side of the epiphysis to preserve the periosteal attachment to the epiphyseal line. This safeguards to a large extent the possibility of extension to the joint.

If frank pus is encountered, our experience shows that this incision is sufficient, if a drain is kept in for a time. If no gross pus is encountered, the periosteum is stripped for a short distance on either side of the incision, to be sure that the incision is not in the wrong place.

If still no frank pus is seen, a series of possibly three drill holes is made from the cortex, obliquely downward toward the epiphyseal line. These are about one fourth of an inch (6.4 mm.) apart up the cortex, and extend at least into the center of the shaft at the epiphyseal line, as shown in the diagram (Fig. 18).

Cultures from the débris removed from these drill holes always show infective organisms, even though free pus is not obtained. These establish clear lines of least resistance, and within twenty-four hours pus is draining freely.

In no case have we opened the medullary canal, and in all cases the infected bone seems limited to the area present at the time of establishment of drainage.

The treatment usually advocated, of trephining an opening into the medullary canal, $2\frac{1}{2}$ inches (6.4 cm.) or more up the shaft, seems, in the light of our experience, to be pernicious.

If the periosteum is opened and holes drilled into the shaft at the metaphysis (Fig. 18), one can hope to relieve the symptoms and prevent necrosis sufficient to produce sequestration. Even if free pus has stripped the periosteum, if it is confined to a small area, regeneration of the necrotic area may take place without sequestration. The subjoined case illustrates this type.

A. B., a boy, aged 12 years (Fig. 19), had sore throat, headache and cervical adenitis, one week before onset of symptoms in the arm. Two days before admission he had pain, which increased in severity just above the left elbow. Slight swelling was noted the day before admission.

On admission he had pain just above the left elbow, some swelling and redness over the inner aspect of the humerus, with pitting on pressure and exquisite tenderness. Movement at the elbow was nearly complete in range, and only painful when the arm was extended to its extreme length. The temperature was 103 F.; the pulse, 150; respirations, 30; white blood cells, 24,000; polymorphonuclear leukocytes, 98 per cent.

A free incision over the inner side of the lower end of the humerus, above the epiphyseal line, opened a cavity containing $\frac{1}{2}$ ounce (15 c.c.) of pus. Culture from this pus showed a hemolytic streptococcus. A blood culture taken at the same time was sterile.



Fig. 16.—Usual appearance of untreated bone.

The boy had a rapid convalescence, and was discharged from the hospital at the end of three weeks, with the wound healed. It has remained healed ever since, now one year.

Figure 20, a roentgenogram taken four months later, shows some periosteal thickening and no cancellous tissue change.



Fig. 17.—Roentgenogram taken at a late stage, showing "spotty" infection

In the series of patients under treatment there are six that have been similarly treated; and the wounds have healed in three or four weeks without a sequestrum being formed. There are also three patients with positive blood cultures on repeated examination, who recovered with greater or less sequestration of necrotic bone.

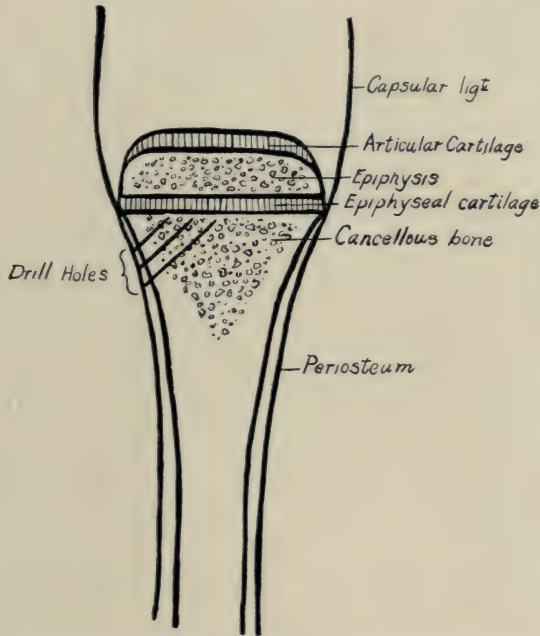


Fig. 18.—Series of drill holes from cortex to epiphyseal line.

In the later stages the plan of treatment adopted is this: After efficient drainage has been established, operation is delayed until the sequestrum is separated. Then a channel sufficiently large to remove the sequestrum is chiseled through the involucrum; the cavity is gently curetted until it is free of dirty granulations; the cavity is sponged with iodine, and packed tightly for forty-eight hours with iodoform gauze after which all packing and drains are removed. If the cavity left is too large to fill easily by granulation, the edges are made saucer-shaped, or flattened, to permit the soft tissues and periosteum to fall in and obliterate it.



Fig. 19.—Arm of patient on admission.

It is rare to find in hematogenous osteomyelitis the large central cavities that one finds in osteomyelitis near the extremity of a long bone following a gunshot wound, which can best be obliterated by a transplanted muscle flap.

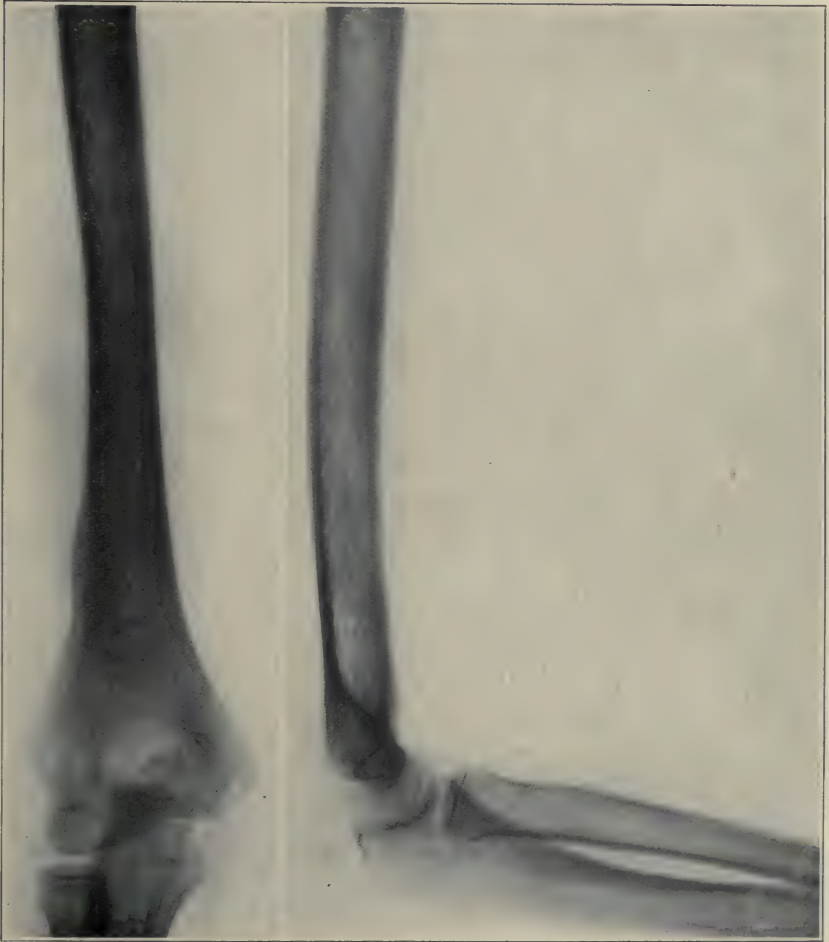


Fig. 20.—Arm of patient, four months later.

The practice of attempting to chisel away necrotic bone before it has delimited itself is to be condemned, as it is impossible to determine where the necrotic bone ends and where the living bone begins. Living bone is thus either taken away or necrotic bone left.

In the operation of making a depressed or saucer-shaped cavity the periosteum should not be widely separated from the living bone, as this is likely to interfere with the circulation of the bone tissue immediately underneath, which may also have its endosteal circulation cut off. This would, of course, make a new necrotic area and subsequent sequestrum.

The blind curetting of a bone cavity where there may or may not be a sequestrum is not a procedure which is likely to produce any beneficial results. In our experience the sequestrotomy should be performed in a bloodless field, using a tourniquet wherever it can be safely used.

Ill-considered and incomplete operations in the latter stage are largely responsible for the fact that in so many of these bone cases discharging sinuses continue for years, and the patients are subjected to operations without number.

DISCUSSION

ARTHUR DEAN BEVAN: We were for many years altogether too radical in our handling of these cases and have done damage by too much traumatism at the time of the early operation in acute osteomyelitis. The experience of Dr. Starr is the experience of the Heidelberg Clinic in the last ten or fifteen years. The difference in the result between the radical procedure in osteomyelitis and the more conservative procedures has shown that the conservative procedures have saved about twice as many lives. Many of us have felt that we should expose the focus and thoroughly eradicate it. We frequently have in the same case within a period of a week or ten days or two weeks this sort of experience: A primary focus in the tibia, which is pretty extensive and acute and followed by destructive bone changes; within a week there is a secondary point of infection in the lower end of the opposite femur and within a few days another lesion, let us say in the elbow joint and the fading in severity from the first severe infection as compared with the second and third is often noticeable. Now when we do a radical operation it is with the conception that we are going to clean out the disease with the removal of this focus as we do when we remove an infected appendix, and it is a wrong conception of this disease because often the patient will have his secondary focus, his tertiary focus or even a fourth or a large number of foci. If we obtain good drainage of the primary focus with slight traumatism, we are doing much more for our patient than we can if we attempt the old, radical operations.

Many of our colleagues are doing mastoid work who do not understand the principles of general surgery as they should and they are overdoing much the operation in acute mastoiditis just exactly as many of us have overdone the operation for osteomyelitis in other fields. There is no doubt in my mind that in acute mastoiditis we should be governed by exactly the same principles that Dr. Starr has laid down, that we are to expose the field and that we are to obtain drainage with the least amount of trauma, and if we do this we shall save more lives than are saved in these very radical operations in the acute stage of the infection and we shall have fewer sinus thromboses and brain abscesses.

A. J. OCHSNER: The operation that Dr. Starr proposes in acute osteomyelitis changes the direction of the lymph stream. The moment you have laid open the periosteum there can be no further backing up of infectious material as shown in the diagram, and the amount of destruction that has taken place is all that will take place. I should like to emphasize the importance of locating the origin of the infection and to advise invariably to eliminate the origin of the infection when this is possible.

C. L. STARR (closing): I came down thinking I was going to drop a bomb into things and that I would probably go home without my scalp. I am glad that Dr. Bevan feels as he does regarding the conservative treatment and I hope his influence will be sufficient to change the character of our textbook teaching, as mine has not been. You cannot pick up a textbook in this country without finding this statement, that when the infection is not found under the periosteum, we must trephine into the medullary canal. In some they go so far as to say it should be laid open from one end to the other. Our students are learning that method. If we are going to relieve the condition we must have early diagnosis and the early diagnosis must be made from the symptoms before there are obvious signs. Look for the lesion in the bone and having located that, get sufficient drainage, thus you will cure the case without sequestration. I think that is the thing to look forward to. Another point, in some textbooks the diagrams are diabolical. You will see in a number of books a focus in the center of the shaft. No man here ever saw acute osteomyelitis in the center of the shaft. That diagram makes an impression on your students and it is hard to eradicate it. Right next to that diagram you will probably have an x-ray plate showing the true location of the osteomyelitis, in the region of the epiphysis. Such things should be eradicated, so that we may have some foundation for our students for real work. I think that is the factor we have to consider in all our teaching. It is very difficult to fight against tradition.

DR. WENDELL C. PHILLIPS, New York: I would like to ask, whether in what we call abscess of the temporal bone it is true that to merely trephine a hole into the temporal bone and drain it is going to bring as good a result as a complete mastoid operation.

A. D. BEVAN: I have in mind the conception that Sir William Macewen held regarding acute mastoiditis of simply opening the mastoid cells and mastoid antrum. I mean in the very acute cases. I believe this plan is much safer than doing a radical operation in the face of an acute infection.

DR. WENDELL C. PHILLIPS, New York: I cannot refrain from challenging the statement of Dr. Bevan regarding purulent middle ear infection involving the mastoid bone. This audience should not be allowed to go out with the impression that merely to drill a hole in the cortex of the temporal bone and let the pus drain is better than to do what we otologists have found is the best, namely a complete and thorough eradication of the disease in the temporal bone, because this procedure gives a more complete and rapid healing. By so doing our statistics show that we have far less complications and that complications like lateral sinus thrombosis are much more liable to occur after incomplete operations. Furthermore, the middle ear suppuration is apt to be prolonged after incomplete operations. All otologists are called on to reoperate and often to do the radical mastoid operation on these halfdone operations. With rare exceptions acute mastoiditis is not to be considered as osteomyelitis of the mastoid.

SURGICAL VERSUS MEDICAL TREATMENT OF GASTRIC AND DUODENAL ULCER

ARTHUR DEAN BEVAN

February 3, 1922

During the last ten years or more I have had the opportunity of making, with my medical colleagues at the Presbyterian Hospital, a combined study from both the medical and surgical point of view of the subject of peptic ulcer. I believe that we have approached this matter with an open mind and have attempted in this clinical research first, to establish the relationship between the clinical picture and the pathologic anatomy, and second, to determine the value of both the medical and the surgical treatment and the indications for each. During this period of ten years, of course, similar researches have been made in a large number of clinics, both in this country and abroad; notably in the Mayo Clinic in Rochester, the work of the Leeds group in England headed by Moynihan, the work of von Eiselsberg and his assistants, Haberer and Clairmont, and the work of Schmieden, who was formerly with Bier and who now has a chair of surgery at the new University at Frankfurt, and, of course, the work of many others.

I shall attempt to summarize briefly the results of my experience with this problem. In the first place, I think it might be well to discuss the present status of our knowledge of the etiology of peptic ulcer. Peptic ulcer is a lesion in which a number of factors play an important part in causation; but, of course, that is true of almost all lesions. Take, for instance, such a simple lesion as a furuncle on the back of a man's neck. I have for years taught my students that here we had at least three causative factors and have expressed the matter by algebraic equation: $X + Y + Z = \text{furuncle}$. In this equation X is the essential germ cause, usually *Staphylococcus aureus*; Y is the small abrasion produced usually by a rough collar which furnishes the atrium of infection; Z is the general lowered resistance of the person that permits the growth of the organism in his tissues; these three factors combined produce the resulting boil.

I think the peptic ulcer is probably a more complicated condition than the simple boil, and that we have at least three and probably more factors in its causation; if we expressed these in the same algebraic

way we would have $X + Y + Z =$ peptic ulcer. I am rather inclined to put the X in this equation as the gastric juice with its power of digesting devitalized tissue. I place this first because it is the characteristic factor of peptic ulcer which does not occur in the absence of gastric juice; Y is an area of lowered local resistance resulting usually from some injury or disease of the blood vessels of the mucous membrane interfering with the blood supply of a small area of tissue and so lowering its vitality that the gastric juice can destroy and digest it; Z is again the lowered general resisting power of the person, and I think in this case probably a rather complex picture as this lowered resisting power may be due to a number of quite different causes.

First, anemia is undoubtedly one of the conditions lowering the resisting power of the patient. General poor nutrition is an important factor. This has been well demonstrated in the last war when the hunger blockade of the Central European countries was followed by an enormous increase in peptic ulcer, due principally, of course, to the lack of proper food and to food often that is difficult to digest. Another factor which lowers the resistance of the person and plays an important part in the production of peptic ulcer is the increased nervousness of the patient. Nervous strain "worry" is recognized by a number of investigators as being one of the important factors in the development of peptic ulcer. This may produce its effects in several ways, increasing possibly the high acid content of the gastric juice, and possibly by producing pyloric spasms, or possibly by producing lowered resistance against the action of gastric juice by impairment of proper nerve function, although these last suggestions are of course purely theoretical. I think we can safely say that all of these three factors—the $X + Y + Z$ —which I have described, play important parts in the production of peptic ulcer.

There has been a good deal of investigation of late years directed toward demonstrating that focal infections, such as in the teeth, tonsils, an infected appendix or infected gallbladder, might be the causes of peptic ulcer by producing hematogenous septic infarcts of areas of the mucous membrane of the stomach. Rosenow has particularly called our attention to this point, and there can be no doubt that infections occur in which we have the picture of an acute ulcer of the stomach or duodenum which results from a hematogenous infection of septic embolism of a vessel of the mucous membranes of the stomach, from a focus of infection such as in the tonsils or teeth or from an extensive

area of skin infection following a burn. My own impression is that these acute cases usually recur promptly, or if they are very serious may result fatally of course; but I believe that it is not the ordinary common cause of peptic ulcer of the stomach and duodenum which we see clinically, and that the infection from pus organisms plays a minor rôle in the causation and the persistence of peptic ulcer.

I shall now present briefly my conception of the symptoms of peptic ulcer, especially the essential and common symptom of stomach distress. The sensations experienced by the patient with peptic ulcer may be described as a sensation of discomfort or distress, or of actual pain. We surgeons who operate today, frequently under local anesthesia, on abdominal viscera recognize the fact that we can handle the stomach and duodenum with little or no distress to the patient. We can sew the stomach and intestines together as in a gastro-enterostomy without any sensation. We can take a cautery and burn off the end of the stomach or duodenum without any sensation, and we sometimes wonder why an ulcer in the duodenum or in the stomach produces pain and how it produces pain. We know that if in performing an operation under local anesthesia we pull on the viscera we can produce great pain. We know too that in the abdominal cavity the most common cause of pain is distention of some viscus, as is clearly shown in the great pain resulting from obstruction of the cystic duct in gallstone colic, or the great pain resulting from obstruction of the ureter in kidney-stone colic, or the great pain resulting from the obstruction of the bowel in ileus. In these cases we can quite clearly see and it can be demonstrated experimentally and clinically that it is the intravisceral tension which produces the pain. We know too that the tissues that are the site of an inflammatory process are much more painful than the normal tissues in the body cavity.

Pain, as I have studied it in peptic ulcer, occurs under three conditions: First, when there is an intravisceral tension due to the distention of the stomach or the bowel with gas and food, and associated often with a spasm preventing the normal emptying of these structures; second, pain which seems to be due to the irritation of the gastric juice on the raw surfaces of the ulcer, the so-called chemical pain; and there is a third kind of pain which undoubtedly is due to the lighting up of an acute inflammatory process in and about the ulcer itself. This sort of pain is apt to produce a picture in a case of duodenal ulcer resembling closely a gallstone attack. I have been able to unravel a number

of cases in which, because the character of the pain so closely simulated gallstone colic, we had made that clinical diagnosis before operation, and in which at operation I have found no lesion of the gallbladder but an inflamed and often a penetrating ulcer, usually either in the duodenum or close to the lesser curvature.

I can understand quite well the stomach and duodenal pain which results from intravisceral tension and the pain which results from an acute inflammatory process developing in and about the ulcer. In the light of the fact that we can crush a part of the stomach or the duodenum or cut it off or destroy it with a cautery without producing any sensations to the patient, it is difficult to understand how gastric juice poured over the raw surface of an ulcer can produce pain, unless we accept the theory that in this pathologic condition of ulcer the tissues are more sensitive than under normal conditions; this, I take it, is the fair and logical explanation of the facts. I am quite willing to accept the generally accepted belief that the ordinary pain of peptic ulcer is due to the pouring over the raw surface of acid gastric juice with a high free hydrochloric acid content, and I think we are compelled to accept this point of view by the results, which we can so constantly observe, of the neutralizing of free hydrochloric acid with alkalis, with the resulting cessation and disappearance of the pain. I wish, however, to say that I believe that intravisceral tension plays a definite and important part in the distress and pain of peptic ulcer, as it does in almost all painful conditions of the abdominal viscera. I believe that this phase of peptic ulcer deserves special study and that when this problem is solved we shall have learned that here, as in almost all painful abdominal lesions, intravisceral tension plays an essential part.

I shall next present to you my conception of the healing of these ulcers. I want to make a parallel, as I have done in my own study of this trouble, between the ordinary varicose ulcer of the leg and peptic ulcer. We can study the healing process of an ordinary varicose ulcer and watch the process directly under our eye from day to day and see what happens in the healing of an ordinary varicose ulcer. First, let me again apply our algebraic equation that $X + Y + Z = \text{varicose ulcer}$. In this algebraic equation the X, the essential and characteristic factor in the etiology, is the obstruction of the return circulation; Y is usually some slight traumatism of the skin—barking the skin from some little injury. This slight injury becomes the starting point of an ulcer, sometimes of considerable size. Instead of healing,

the tissues about the injury break down and the ulcer grows in size; Z is the general resisting power of the individual again, and this is modified by poor nutrition, poor hygienic surroundings and general constitutional disease. If one makes a culture of the secretions of the varicose ulcer, he will have no difficulty in demonstrating pus organisms of various kinds and often saprophytic organisms. I believe, however, that these organisms do not play an important part, either in the production of the ulcer or in preventing the healing of the wound. Of course, at times a varicose ulcer becomes acutely infected and inflamed. I would draw, therefore, a close parallel between the varicose ulcer and the peptic ulcer so far as pus organisms are concerned; that is, that they are present in both, that they are, however, as a rule simply an incident, and that they may occasionally be the cause of the lighting up of an acute infection, but that they are not the essential cause of the ulcer.

Now let us examine the natural history and the healing of a varicose ulcer. I think I can speak on this subject with some authority as I have watched carefully a large number of these cases. Keeping in mind the X and Y and Z which equal varicose ulcer, if we place the patient at absolute rest in bed in a recumbent position and elevate the affected limb, we do away for the time being with the X, the most essential factor in the production and maintenance of varicose ulcer; that is, the interference with the return circulation. If we do this only without attempting to do anything else, as a rule in a limited period (10 days to 2 weeks or more) the ordinary varicose ulcer will heal. In the healing process the bacteria which are on the surface gradually disappear and granulations become healthier, and with the complete epidermization of the ulcer the bacteria disappear entirely. If the general condition of the patient is bad, if the patient is anemic, run-down, undernourished, of course improved hygiene, better food, fresh air, cleanliness and attention to proper elimination are important in improving the general condition of the patient, and under this improved general condition wound healing is more rapid.

If there is a combined condition, such as varicose ulcer plus syphilis, antispecific treatment is of definite value. In other words, the history of an ordinary varicose ulcer is that when we remove the essential cause and contributing causes and place the patient and the part involved in the best possible condition for healing, especially when we remove

the essential cause, the interference with the return circulation, wound healing as a rule occurs promptly.

There are, however, some exceptions to this rule. The old-time surgeons recognized the existence of some of these old ulcers of the leg of a certain type which they called "callous ulcers." If you examine one of these, you will find a rim of dense scar tissue around the ulcer and in crater-like depression of the ulcer itself. In these callous ulcers wound healing is very slow and sometimes almost impossible to obtain under the ordinary elevation of the limb, rest and improved general condition of the patient, which is so efficient in varicose ulcer of the ordinary type. Old-time surgeons understood this problem very well, and in order to heal one of these ulcers they would dissect out the hard indurated callous margin of the ulcer and the base of the ulcer itself, then place the patient in a recumbent position and treat the ulcer as the varicose ulcer of the ordinary type and obtain healing.

There is a third type which one might mention in continuing this parallel between the varicose and peptic ulcer, and that is the old chronic ulcer in which such great changes have occurred at the site of the ulcer that the tissues have apparently lost their power of repair. Not infrequently in these cases we must dissect out the ulcer and either graft skin or cover the area with a flap by some plastic operation.

I would like now to ask you to keep in mind this picture of varicose ulcer as I have drawn it and apply it to the study of peptic ulcers. I think that very much the same thing happens in the ulcer in the interior of the stomach and duodenum that happens in the ulcer on the leg. If we can place a peptic ulcer under conditions in which we eliminate, as we can do in a varicose ulcer, the essential causes which produce and maintain the ulcer, we can in the vast majority of cases succeed in producing healing on the interior of the stomach and duodenum just as we can on the skin. In order to do this it is clear that we must place the patient at rest in bed, and we must place the stomach and duodenum at rest as much as possible. There is no doubt in my mind that rest in bed is desirable, certainly for three or four weeks. Local rest of the stomach and duodenum are obtained by removing food traumas and by the blandest possible diet. This, of course, is the practical method which we employ in clinical work.

We can demonstrate absolutely the value of rest in healing these peptic ulcers by the results which can be obtained from jejunostomy. If, for instance, under local anesthesia we pick up the first part of the jejunum

and introduce a small rubber tube into the jejunum, doing the operation with good technic so as to prevent any leakage and resulting peritonitis, and maintain this tube in the jejunum for a number of weeks, or even months, and put nothing of any kind in the stomach but feed the patient entirely through this jejunostomy tube, we in this way, of course, place the stomach and duodenum at absolute rest, and we can cure almost any of the peptic ulcers in the stomach or duodenum in this manner. That has been demonstrated now in a number of cases. I think we should keep this in mind as a definite illustration of the importance of rest in the healing of peptic ulcers.

In the third place, and very essential, is the neutralizing of the acid of the gastric juice so as to prevent the irritating digestive effects of the gastric juice on the raw ulcer surface. In the fourth place, of course, we must place the patient, handicapped as he is by being in bed, under the best possible hygienic conditions as far as food, fresh air and nursing are concerned to improve his general condition. In the large majority of peptic ulcers, rest of the patient in bed, rest of the stomach and duodenum neutralizing the gastric juice and improving the general condition of the patient will result in the course of some weeks, or possibly several months, in a complete healing of the ulcer. There are, however, definite exceptions to this rule. I think there is no doubt that old callous ulcers of the stomach and duodenum are often refractory, just as old callous ulcers of the leg are, to this rest treatment, and when the ulcer is situated so as to impair seriously functions of the stomach and duodenum, as at or near the pylorus, producing obstruction and deformity, complete wound healing cannot as a rule be obtained by medical management alone.

By the rather rough outline which I have drawn I want to present to you this conception that both the ulcer of the leg and the ulcer of the stomach and duodenum are the result of a number of causative factors; that when we recognize these factors we are in a position to apply this knowledge in a practical way in the cure of the disease; and that the cure depends on recognition of the principle that if we eliminate altogether, or a large part of, the causative factors, we can as a rule place the patient and the local lesion in a condition in which healing can go on to completion, and we can cure the disease. Although we can cure the great majority of peptic ulcers by a scheme of medical management on the principles which I have outlined, there remains a considerable number of cases, just as in ulcers of the leg, in which

we must resort to something more than medical management, namely, to surgical treatment.

We can cure a varicose ulcer of the leg by proper treatment. We can cure a peptic ulcer by proper treatment. We want to remember, however, that the ulcer in either case may recur, that it may recur at the original site, or a new ulcer may develop, and that this is apt to happen unless we take pains to eliminate to some degree at least the causes which produced the ulcer in the first instance.

In the case of the varicose ulcer the important factor of interference with return circulation can be remedied often by wearing a proper bandage or by a surgical operation removing a segment of the veins and breaking the long column of blood. In the case of the peptic ulcer, if we are to prevent recurrence, which is unfortunately common, we must by proper attention to diet and the general condition of the patient eliminate the acidity and food traumas, the nervous tension and the bad general conditions which were responsible for the ulcer in the first instance. The person who has been cured of a peptic ulcer must know that the price of a permanent cure is eternal vigilance, and this is true whether the cure has resulted from medical management or surgical operation.

Now let us turn to the surgical treatment of peptic ulcer. Surgical treatment includes operations for perforation, for pyloric obstruction, for hour-glass stomach, and operations for the actual removal and the resection of the ulcer. It includes also gastro-enterostomy and jejunostomy. There can be no question, of course, about the necessity and great value of the surgical treatment for perforation and for cicatricial and unyielding pyloric obstruction and for hour-glass stomach in which the deformity produces symptoms. All internists and surgeons agree that these conditions demand surgical treatment.

What can surgery do to cure chronic uncomplicated peptic ulcer of the duodenum and stomach?

1. The ulcer can be excised by one of several methods, and the patient cured by an operation which carries a certain amount of risk which varies enormously with the skill and experience of the operating surgeon.

2. Ninety per cent. of ulcers of the duodenum and 50% or more of ulcers of the stomach can be cured by a gastro-enterostomy, which again carries a certain amount of risk, probably less than 2%, in skilled

hands, with an associated risk of developing a jejunal ulcer in 3% or more of the cases.

How does a gastro-enterostomy cure an ulcer in the stomach and duodenum? This has been answered in several ways. Patterson believes that the important factor in the cure is the neutralizing of the acid gastric juice by the alkaline bile and pancreatic juice which results from their pouring into the stomach through the new opening. Admitting that there is probably some truth in this theory, I believe that the value of a gastro-enterostomy is in the safety valve action of the new opening. Let us apply this conception to a gastro-enterostomy for a duodenal ulcer in which the prospects of cure are, I believe, 90%. I visualize the result in this way: As soon as the gastro-enterostomy has been performed, a spasm of the pylorus occurs which prevents the gastric contents from passing into the duodenum, and as a result the gastric juice and food take the course of least resistance and pass out through the new opening. The duodenal ulcer is thus put at rest, is protected from the irritating actions of the gastric contents, and wound healing proceeds rapidly and the ulcer heals. As soon as the ulcer heals, or possibly even when it begins to heal and becomes covered with healthy granulations, the pyloric spasm lets up in whole or in part, and the gastric contents begin to take the normal course through the pylorus. In my mind one of the reasons for the marked relief which follows gastro-enterostomy is probably the relief from intragastric tension which the gastro-enterostomy affords. In the case of the cure of a gastric ulcer produced by a gastro-enterostomy I believe this relief from gastric tension, the freer emptying of the stomach and the neutralizing of the gastric juice by the bile and pancreatic furnish the logical explanation.

I have already referred to the cure of peptic ulcer by the operation of jejunostomy. Here the explanation is definite. The ulcer whether in the stomach or duodenum is at once placed at rest by feeding the patient through the jejunal tube, and healing usually goes on rapidly. The operation is, however, in spite of its efficiency, not a practical method of treatment and should be reserved as a preliminary procedure in seriously handicapped patients. I was in one case able to save a man's life by a jejunostomy, who had at the time of the operation only 17% hemoglobin.

What can be said of the operations for excising peptic ulcers? This can be done either by an oval or wedge-shaped excision, when the

conditions permit, or by transverse resection of the stomach, or by what is now being tried rather extensively—a resection of the stomach and duodenum by the Billroth 2 and the Billroth 1 operation. The excision of the ulcer seems the ideal treatment. The risk, however, is considerable. It is the operation of choice where it can be done without great risk and without resulting deformity. A new chapter is being written at this time in stomach surgery by the men who are doing the extensive resections of the duodenum and stomach, which are termed the first and second Billroth methods. These operations have proved, in the hands of a few expert surgeons, surprisingly successful. Moynihan, Haberer, and Clairmont, Eiselsberg and Schmieden have reported series of 50 or more cases with a death rate of 1-2%. I have personally been much impressed with the Billroth excision for ulcer and am trying it out in a series of cases, especially in cases of callous ulcers in which the possibility of carcinoma must be considered.

The Billroth excision accomplishes definitely three things:

1. It removes the ulcer.
2. It removes the pylorus and the element of pylorospasm.
3. By removing a considerable amount of the secreting surface of the stomach it diminishes the free hydrochloric acid content of the gastric juice; and finally it removes with the ulcer a possible existing or a potential carcinoma.

Now that we have reviewed the essential principles of this subject, let us ask ourselves how we shall apply this knowledge in actual practice, let us say in a hundred ulcer cases? I believe that we can make this matter simpler and clearer if we answer the question: With our knowledge of this subject, how would you and I like to have our ulcer of the stomach or duodenum treated? After all this is the real test. If I had a peptic ulcer uncomplicated by any of the conditions which we all agree demand surgical treatment—perforation, pyloric obstruction from scar, etc.—I would want to have it treated by a scheme of sound medical management and would place myself in the hands of my colleagues, Sippy or one of his disciples, because I believe that he has worked out the best method so far devised. I believe that my chances of cure would be 80 to 90%, and that I could keep well if I took reasonable care of myself. I would recognize the fact that there was a certain definite risk of recurrence. How large is difficult to state in figures.

If in the history of my case I had had repeated hemorrhages and the evidence showed that the ulcer was in the duodenum, I would want to be operated on by one of my good surgical colleagues who had devoted special attention to this subject. If in the course of the disease marked pyloric obstruction occurred, I would want to have a gastro-enterostomy performed. If in spite of good management I was not completely cured and symptoms recurred on slight provocation, I would want to have a gastro-enterostomy performed. If in spite of good management of the ulcer the symptoms persisted, I would want to be handled as a carcinoma suspect and be given the benefit of an exploratory operation. If at the operation a callous ulcer was found, I would want the benefit of a second Billroth operation. If I had an operation for ulcer, either a gastro-enterostomy or a resection, I would want to be given medical ulcer management as a part of the after-care for the purpose of reducing to a minimum the chances of a jejunal ulcer.

If I attempt to put the question of the medical and the surgical treatment of ulcer into figures, I would do so about like this: Almost all ulcers in their early history should be handled medically. When they persist under good medical management, when they recur in spite of good medical management and the care which the patient can obtain in his or her peculiar station of life, when serious and repeated hemorrhages occur, when pyloric obstruction does not yield to good medical management, when there is a reasonable suspicion of malignancy, medical management should not be too long persisted in but should give way to exploration and surgical therapy as the safer plan and the plan which affords the better prospect of cure. Numerically I believe that the cases demanding surgical treatment would include about 10% of the ulcers of the chronic type.

To visualize this a little more clearly let us take 100 cases of peptic ulcer. Practically all of these patients should be given at first the benefit of sound medical management. Possibly 90% of these can be cured and kept well by medical management. Probably 10% after repeated trials of medical management will prove refractory and should then be given the benefit of exploratory operation and surgical therapy. I have no sympathy for the position taken by some surgeons that ulcer of the stomach and duodenum are conditions like gallstone disease that are to be relieved by surgical operations. Nor have I any sympathy with the position taken by some gastro-enterologists, that all ulcer cases must be handled medically and that surgical therapy should be postponed

as long as possible and should be regarded as a last resort. To my mind the great value of medical management has been clearly shown, especially by Dr. Sippy and his disciples. They have shown that peptic ulcer can be cured by medical management, and that the great majority can be so cured.

On the other hand, no more brilliant chapter has been written in the history of surgery than the chapter on gastric and duodenal ulcers. We owe to our surgical colleagues most of the knowledge that we have of gastric and duodenal ulcers; the knowledge which we have obtained by necropsies in vivo which we have made during the last twenty years. Twenty years ago we hardly knew that there was such a thing as a duodenal ulcer. The surgeons furnished us with the knowledge of its existence and its frequency. The surgeons made mistakes in the development of this subject. They performed too many gastro-enterostomies. They placed too little value on medical management. But in spite of mistakes, great progress has been made, and today we can say with much confidence that when ulcers prove refractory to medical management, modern surgery offers much to the patients. The ideal situation is the joint handling of these cases by an internist and a surgeon who both realize the field of usefulness and the limitation of both the medical and surgical management, and who give to their patients the benefit of their combined judgment and the treatment demanded in each individual case.

DISCUSSION

B. W. SIPPY: From my point of view, Dr. Bevan has presented this subject in a sane manner. With a few modifications, most of them of minor importance, the statements that he has used might well express my views on the subject, so that what I shall have to say to you will be largely a repetition or amplification or presentation of the same views with a combination of words a little different than he used.

My program stated that the paper was on "The relative value of the medical and surgical treatment of ulcer and the indications for each." I like that title much better than "The surgical versus medical treatment of gastric and duodenal ulcer." Medical versus surgical implies an antagonism, a conflict. The other title I like better.

Now, there are a number of factors entering into the relative value of these two procedures. I should say that they might be collected into three great factors that stand out: The first factor, is the conditions that attend the ulcer. The second great factor, and it is a most important one, has to do with the character or type of surgical management to which the patient is subjected, the skill of the surgeon who is to do the operation standing foremost. The third factor that has to be considered is the type of medical management that is to be instituted and the efficiency of it.

The particular type of medical management in common use the world over is the Leube and its various modifications, which consist in putting the patient to rest, giving good nourishing food. In many instances the ulcer heals, and, particularly if the treatment is instituted early, the treatment will result in a cure in many cases. My conception of peptic ulcer is that many of the ulcers that develop are symptomless and heal without trouble. Most of the ulcers that develop in the stomach we do not see and the surgeon does not see them, but they heal and leave a scar. That is why the pathologist finds ulcer more frequently in the stomach than in the duodenum, and we as clinicians find them in the duodenum more frequently than in the stomach. We must analyze carefully these important factors before we are ready to talk about the relative value of these two procedures.

Relative to the first factor, the conditions and complications that attend ulcer, they have a most important influence. Necessarily to evaluate them properly we must have an accurate diagnosis. An accurate diagnosis must show first, whether an ulcer is present; second, what complications if any exist, and third, what is the probable location, the extent and whether it is movable or not; is it on the stomach side of the pylorus or on the duodenal side of the pylorus; how deep is the ulcer, how broad; how long has it existed; if recurrences have occurred, how frequently? By main complications we mean is a cancer present or is pyloric obstruction present; if so, is it due to pylorospasm, inflammatory swelling, local peritonitis or is it due to a cicatricial narrowing? Is excessive secretion present; are gastric adhesions present; are perigastric abscesses present? Is an hour-glass stomach which interferes with the motility of the stomach present, or is hemorrhage depleting the patient? If one knows what to look for and how to go at it, it does not take long to determine about these things. When we know these things we are able to say whether the patient should be treated medically or surgically. The question does not become a general one of whether to treat medically or surgically, but the question is whether this particular case with all these circumstances present is one to be treated medically or surgically.

There are certain definite indications for surgical treatment. Dr. Bevan has named some of them. These are absolute indications. If there is a reasonable reason for suspecting that cancer is developing an operation should be performed at once. Perigastric abscess is a surgical lesion. Many patients with hour-glass stomach may be well treated surgically. I have mentioned perforation. Acute hemorrhage is seldom treated by the surgeon. Chronic hemorrhages are amenable to medical management when peptic ulcer is treated. One of the easiest things we have to deal with is persistent oozing. When these complications that may attend ulcer and may be mechanically removed are set aside as clearly surgical, what can the surgeon do to promote the healing of the ulcer? Let me say that in pyloric obstruction through our experience we have learned that 85% are relieved by careful medical management. The introduction of free hydrochloric acid takes away the most important irritant. The symptoms let up, the acute inflammatory swelling lets up and the motor meal will pass in the normal time in two or three weeks. Fifteen per cent of the patients will not improve. These cases are surgical in the presence of a good surgeon and no contraindications.

When the cases which are on a mechanical basis have been set aside, what can the surgeon do? There are certain instances in which the ulcer is so located that it may be excised, in which it may be reduced in size by the cautery; a resection of the stomach may be performed. These operations, such as excision,

resection of the stomach, etc., are not to be made unless they are made by an expert. The mortality in the hands of an expert is not high, but when made by those who are trying to imitate the experts the mortality may vary from 1 to 100%, depending on the skill of the operator.

Is it necessary to perform these operations of excision? You know how Moynihan feels about it. He says it is not right to excise an ulcer or cauterize it and perform a gastro-enterostomy. He says ulcers of the stomach can be treated by gastrectomy. He has a mortality of 4.7% and he can get away with it. Imagine what the mortality will be if the average surgeon is to do the operation. An ulcer may be so old or so large or both that the condition cannot be cured without excision of the ulcer. Let it be done by the expert. This involves the second factor in the management of ulcer—the character or type of surgical management and the skill of the operator. If we had experts only a patient with an ulcer would be reasonably safe in their hands, but experts are not going to operate on the vast majority of patients with ulcers. If surgical treatment is the only treatment that can be employed with fairness, then operators all over the country will try to imitate the experts.

What does a gastro-enterostomy accomplish? My conception is not quite the same as Dr. Bevan's. With a gastro-enterostomy the stomach empties itself in normal time. The 24-hour retention is reduced to from 9 to 12. The same is true of ulcer on the lesser posterior curvature without perforation unless it produces hemorrhage or is located on the stomach side, producing obstruction. The duration of contact of the irritant is not as long as in duodenal ulcer when it is obstructing. This duration of the contact of the irritant—we will not say what it is, theoretically it can be a number of things—varies considerably. This irritant is allowed to go out in normal time after a gastro-enterostomy. That places ulcer of the duodenum in the same position for healing with the action of the irritant as a posterior wall ulcer or a lesser curvature ulcer. If the common conception of the duration of contact of this gastric juice, as Dr. Bevan brought out, is removed in a few hours, the nutrition of the ulcer may be sufficient to go on and held even in the presence of a few hours of corrosive substance.

What does a gastro-enterostomy do aside from relieving the obstruction? So far as anybody knows, nothing else can be done. Can this be accomplished by any other means? If the common conception of peptic ulcer is correct, namely, that the gastric juice produces the greatest hindrance to control, it follows that the healing of the ulcer will be accomplished by a means best adapted to relieve this peptic activity. It is done by the means we have been employing for the last seventeen years. We presume that the gastric juice has nothing to do with the healing. When the ulcer is well nourished, the gastric juice has nothing to do. It is only when there is a corrosive action that the gastric juice produces trouble. When that is well managed we believe the vast majority of ulcers will get well. Every one agrees that peptic ulcer, except when there are absolute surgical indications, should be treated medically. Let us have an active educational campaign to that effect all over the country.

A. A. STRAUSS: I was much interested in Dr. Bevan's statements regarding the pain produced by ulcer from intragastric tension. There is no doubt that in any viscus in which there is tension within the lumen there will be marked pain. However, I believe the greatest amount of pain is due to the peristaltic wave and increased contractions that pass over the chronically inflamed ulcer. This corresponds to the character of pain which the patient always complains of when the ulcer is located in the pyloric region of the stomach. Patients always

say that the pain lasts only for a minute or so and then reappears, which corresponds to the peristaltic wave in the pylorus. I have some doubt as to the amount of pain that is produced by the contact of the hydrochloric acid with the ulcer. I have operated on two patients with lesser curvature posterior wall ulcer under local anesthesia, in whom the anterior wall of the stomach was opened and a large posterior wall ulcer exposed. I made the following tests on these patients: I took about 30% hydrochloric acid and dropped it into the hollow of the nest-shaped ulcer; the patient stated that he had no pain. The same strength of hydrochloric acid was placed on the normal mucosa of the stomach, and he said he felt a burning sensation. We took sterile test-tubes which contained boiling water and put them in the callous part of the ulcer, and the patient did not experience a feeling of heat as he did on the normal mucosa. Both patients gave the same reaction to heat and hydrochloric acid. I think it is fair to assume or at least it is suggestive that the normal mucosa seems much more sensitive to acid and heat than does the calloused ulcer; this makes the amount of pain produced by hydrochloric acid in ulcer doubtful. The argument that alkalis relieve the pain is more easily explained on the basis that the alkalization of the stomach contents relaxes the pyloric sphincter and relieves the intragastric tension and pylorospasm.

I also want to call attention to the fact that many of the patients with ulcer, who have had the greatest amount of pain have a normal or subnormal acidity. I mean by that they have a great deal of pain and show by fractional test meals that they have a subacidity.

I believe that the best surgical treatment for duodenal and gastric ulcer is excision of the ulcer with simple pyloroplasty. The mortality is no higher and probably lower than from any other surgical procedure and takes no more surgical skill than simple gastro-enterostomy and is much less of a surgical procedure; in fact, it can be spoken of as a minor operation as compared with gastro-enterostomy or partial gastrectomy. I also believe that by cutting away the sphincter muscle of the pylorus down to the mucosa, over somewhat less than one half of its circumference, and back on to the pyloric antrum for about 1 inch in the form of a pyramid with its base at the pyloric ring, more has been accomplished in giving the stomach a normal or quicker than normal emptying time than by any gastro-enterostomy, and it is a minor operation which takes about two minutes to perform as compared to the major operation of gastro-enterostomy. We have quite a large series of these cases and find them far more satisfactory than gastro-enterostomy. This pyloroplasty does away with the very point that Dr. Bevan brought out, that when you do a gastro-enterostomy you do away with the pylorospasm. So when you excise the ulcer and do a pyloroplasty you have removed the lesion and have given the stomach a normal or quicker than normal emptying time, but in addition you also have left the stomach and duodenum in their normal anatomic and physiologic relationship, which is not true by the other types of operation, such as gastro-enterostomy or partial gastrectomy.

I have had quite a large series of simple ulcer excisions and partial gastrectomies with a very low mortality, but I cannot say that the patient with half a stomach feels as well as the patient with a whole stomach. As to the mortality, and in answer to Dr. Sippy, who stated that only expert surgeons should perform these operations: When you sum up the cases of gastric ulcer treated medically that are found to be malignant a year or so later, and the cases that perforate during or after medical treatment, and those that have fatal hemorrhages during or after medical treatment, and the posterior wall ulcers that

perforate and infiltrate the pancreas—summing up the mortality and these end results which occur during and following medical treatment as compared with good surgical treatment, which has a mortality ranging from 2 to 4%, I think the statistics will be in favor of surgery, especially if we analyze the ulcers which we treat medically for several years and which then become malignant.

I also want to state that a far larger number of surgeons are doing partial gastrectomies and ulcer excisions, of whom we never hear unless we go out through the country to inquire about them, who have a mortality of 2 to 3%. I think there are many, who are learning gastric surgery in our laboratories of surgical technic and who have perfected themselves, that are now learning to do good gastric surgery. I believe that they should be encouraged rather than discouraged, and if so, the standard of surgery in this particular line will show marked progress in a short while.

There are a large number of cases of posterior wall ulcer that perforate into the pancreas, and which many have treated by simple gastro-enterostomy. This, I believe, is unsatisfactory since the patient has the constant pain of a chronic infiltrated and inflamed pancreas. I have operated on 16 patients with this type of ulcer by partial gastrectomy, and I believe the simplest method of attack is by opening the anterior wall of the stomach, which will permit one to see the exact extent of the changes. Then by freeing the lesser curvature one can separate by blunt dissection the adherent posterior wall and the ulcer from the adherent pancreas. A partial gastrectomy should then be made, which I believe is the only type of operation which should be attempted for this type of ulcer.

As to the merits of medical and surgical treatment: I shall answer the question Dr. Bevan asked. If I had a duodenal ulcer, I would have it treated medically. If it did not heal the first time, I would take a second medical treatment; but the economic condition of the patient should be considered. You cannot treat medically for months and months a poor man who has to earn a living for a large family by hard physical labor. You can keep him confined to a hospital or resting in bed only for a certain length of time, while with a wealthy patient this point does not need consideration. On the other hand, I believe chronic gastric ulcers should not be treated medically, but surgically.

ARTHUR DEAN BEVAN: I have nothing to add except to say that medical men and surgeons are writing an interesting chapter on this subject. I am much encouraged to feel that those who are studying these questions from both sides are getting nearer together and that in consequence we are obtaining better results.

CHRISTIAN FENGER AS I KNEW HIM

L. L. McARTHUR

March 10, 1922

The profound impressions created by the advent into these medical circles of such a master mind as that of Christian Fenger can be fully appreciated only by one preparing himself for the practice of medicine and surgery during those epochal transition years between the older humoral or other theories of diseases and the present era of scientific medicine.

Until that period, there had developed in each succeeding generation and in varying countries some outstanding thinkers, who, condensing the wisdom of the sages and adapting it to their personal conceptions of disease, after years of intelligent observation had evolved their own theory and practice of medicine. They endeavored to impart these to their students, with varying success. Certain ones acquired an earnest band of ardent followers, who formed a so-called "school."

To one who had sat at the feet of, and imbibed his earliest impressions of medicine from, such acknowledged thinkers of this community as J. Adams Allen, Moses Gunn, Hosmer A. Johnson, and Nathan S. Davis, would come more sharply the consternation at the radical changes made necessary by the newer pathology, morbid anatomy, and bacterial proofs submitted by the newcomer. He, too, could note more acutely the trace of opposition attendant on the substitution of demonstrable facts for long held plausible theories and sense the tinge of resentment ever directed against an iconoclast. On the other hand, it was a veritable pleasure to watch those beloved masters, as the evidence grew, endeavor to adapt themselves to the new truths as soon as they were demonstrated. Only big broad minds could thus unlearn the teachings of a lifetime, only the love of truth for truth's sake change such set convictions.

Thus, Christian Fenger, coming to Chicago, exerted an influence on Western medicine and medical teachings most revolutionary in character and impressive in extent.

Who, then, was Christian Fenger? When the King of Denmark deigns to honor one of his countrymen by knighthood, the one so honored is required to submit an autobiography for the government records. From such an autobiography by Christian Fenger, Knight of Dannebrog, written with never a thought of its ever appearing in

print, in his prosaic methodical manner, we learn all that is known of his early life. Through the painstaking labors of Dr. Ludvig Hektoen and Dr. Coleman Buford, this autobiography has been translated and serves as an admirable preface to the two volumes of "The Collected Works of Christian Fenger," 1840-1902, assembled by them.

A scholarly summary of Fenger's activities as a pathologist by our pathologist, Dr. E. R. LeCount, so thoroughly covers the field, that I shall refer you to his address before the Chicago Pathological Society, 1903 (incorporated in their proceedings). Dr. LeCount said:

He was born in Jutland on a fine old estate, formerly a monastery, belonging to his father and called Bregringgaard. This is on the west coast of Denmark, near the small town (500 inhabitants) of Rinkjööbing, in an agricultural district, the nearest large place, Aarhus, being 60 miles away on the eastern coast. His preliminary education was obtained at Herlufshalin, 30 miles from Copenhagen, where he spent nine years in a boarding school. He did not particularly distinguish himself here, being hampered by poor sight and a weak knee; recrudescence of the joint trouble also interrupted his medical studies. At the age of 19 or 20 he entered the University at Copenhagen and spent seven and one-half years, obtaining his degree in 1867. During his internship of two years in the Frederik's Hospital he wrote his first articles, but his duties at the "Kommune Hospital," where he was prosector (resident pathologist) for three years, did not begin until 1871, after his service in the Franco-Prussian war as a surgeon.

It would be edifying indeed to know the primary factors influencing his early training, the dominant qualities of the men who taught him and whom he earnestly sought to emulate, his first great ambitions and how they arose. Among his ancestry and in his family a tradition exists that one great physician appears in each generation. A Christian Fenger born in 1773 held many honored positions as a surgeon, and was "ausserordentlicher" professor at the "Akademie" in Copenhagen. Two years before his death in 1845, his nephew, Carl Emil Fenger, was appointed to the newly created lectureship in pathologic anatomy and general pathology at the university. This Emil Fenger was at the zenith of his activity in medicine when the man we learned to respect so highly was an undergraduate. Although the writings of Emil Fenger in medicine were mainly on mortality statistics, he is credited with emancipating medical education in Denmark from the dominance of humoral pathology. This service was largely performed through a polemic with his colleague Buntzen, and originated with an attack by Buntzen on the development of experimental physiology and pathologic anatomy instigated by the growing skepticism for the time-honored empirical therapy.

Buntzen criticized research for its failure to provide definite guiding precepts to therapy and for the large personal element entering into its results. Fenger's reply, entitled "Contributions to an Elucidation of the Present Movement in Therapy" (translated), ran through seven numbers of the hospital journal. Its minutiae cannot be examined here, but it will interest you to learn that his clear conception of the entire problem, his defense of investigation, and distinctions between 'Haltbar' and 'unhaltbar,' not only cleared the atmosphere of doubt and uncertainty for the younger men in the profession, but

denoted a decisive and commanding mentality. Although this episode of Danish medical history sheds faint light on the conditions prevailing when Fenger studied medicine, it is pregnant with revelations of the personality of Emil Fenger, his uncle.

During the latter part of our Fenger's undergraduate work in medicine, there came to the University a distinguished physiologist whose influence we have good reason to believe was responsible to a large degree for his conceptions of scientific work. Panum had previously occupied the chairs of physiology, general pathology and medical chemistry at Kiel for five years. He was not only a pupil of Claude Bernard, but had served as his assistant for a number of years before going to Kiel. His advent in Copenhagen was followed by the introduction of new scientific methods of studying and teaching physiology.

Two years before Fenger graduated, Hans Wilhelm Meyer began his special clinic of throat, nose, and ear diseases, and while an intern in the Frederik's Hospital Fenger devoted considerable time to attending this clinic. It was at this time (1868) that Meyer's epochal work on adenoids of the nasopharynx appeared in the *Hospitalstidende*. There is evidence that these three men—Emil Fenger, his uncle, Panum, the physiologist, and the clinician Meyer—were largely responsible for Fenger's scientific medical training.

In the medical faculty at this time Schmidt, a pupil of Kölliker and of His, was the anatomist; Reisz, who had studied with Virchow in 1861, held the chair of pathologic anatomy; the surgeons were Mathias Saxtorph, Stein, and Buntzen; Dahlerup and With taught internal medicine; Warneke pharmacology; Englested venereal diseases and dermatology, and Stadfeld obstetrics. Many of these teachers wrote textbooks; Engelsted's treatise on the clinical aspects of constitutional syphilis was translated into German. Buntzen founded the *Hospitalstidende*, and was for many years its chief editor; Panum, with Key of Stockholm, the *Nordiskt Medicinskt Arkiv*; and Emil Fenger the *Hospitals-Meddeleser*, which Petersen, the Danish medical historian, has pronounced a literary movement. It is obvious from the foregoing that Fenger's professional education was acquired under auspicious circumstances and in an atmosphere replete with personal impressions of men responsible for many important advances in medicine. When Panum came, as before stated, during Fenger's student days, it was to take the place of Eschricht, who had studied with Majendie and been a personal friend of Johannes Müller and von Baer. We can readily believe that the principles of scientific work so thoroughly understood by Fenger were, at least in part, transmitted to him, through Panum, from Claude Bernard.

My early medical career having brought me in such direct contact with him whose memory we are here to honor, you will, I trust, pardon me if the reminiscences partake of a rather personal character. Coincident with my entrance to Rush Medical College (1877) was the advent of Dr. Fenger to Chicago, where he was induced by his friend, Dr. S. D. Jacobsen, to locate permanently. As a student at, and later as intern on the staff of, Cook County Hospital, I learned to know Dr. Jacobsen intimately as a sterling, scholarly, learned medical man—and his was clearly the influence on Fenger determining his future career as a Chicagoean. Dr. Jacobsen at that time had charge of the eye and ear

department at the Cook County Hospital, and parenthetically, all wise candidates for his vote were at least familiar with the anatomy of Jacobsen's nerve, first described by his uncle. An enlightening remark by Dr. Fenger, in his autobiography, to those familiar with the existing conditions is the following: "In 1878, I secured '*by means of borrowed money*' a position on the staff of Cook County Hospital." At that period, the most corrupt group of county commissioners Chicago has ever had were in control. One thousand dollars was the price for a place on the staff of an institution for the care of the poor of Cook County! An ambitious medical man, with no other reward than to see, study, and heal disease, was compelled to buy his appointment during their regime! I doubt not Dr. Jacobsen was his financial aid.

These first two years of Fenger's service as pathologist at Cook County Hospital exerted a profound effect on the writer, then a student at Rush. As a newcomer and with few friends, Dr. Fenger was given for his clinic the inconvenient hour from one to two—an hour never before assigned to an attending man for a clinic. Twelve to two, in all preceding years, was set aside for luncheon, rest, and recreation. Following custom, the students failed at first to attend in any large numbers. Thus it happened that Dr. J. B. Murphy and myself, fascinated by his wonderful technic in making a postmortem examination, thrilled by the revelations each necropsy offered, and rewarded by his efforts to convey to us the information that should have gone to the entire class, were constant attendants during these first months, one taking down the findings, the other sewing up the cadaver. Undoubtedly, this experience remained ever after a potent factor in J. B. Murphy's future development, as was later true of so many others.

Christian Fenger, although wonderfully well read and a *great* linguist, labored under a peculiarly halting speech that to those hearing him for the first time proved difficult to follow—hence the scant attendance of his classes. One wag remarked "Fenger could stammer in seven languages." The wealth of knowledge in this new world of pathologic and morbid anatomy repaid a thousand-fold those ignoring his poor delivery.

So great was Dr. Fenger's pleasure in conveying his knowledge to those manifesting genuine interest that he frequently forgot engagements, patients, even his meals, while trying to make clear some problem in pathology. Indeed, some of the interns at the County Hospital, in their eagerness to obtain his opinion as to the nature of some obscure

cases would ask him to see the patients. Willing to oblige, Dr. Fenger would see the patient and make the pathologic diagnosis. His diagnosis was frequently at variance with that made by the attending surgeon to whom the case had been assigned. This once resulted in a curt communication to Fenger. Dr. J. B. Herrick will recall the effort made by an intern on a later occasion to induce Fenger to state how a certain fracture of the thigh could be handled. He replied, evasively, "Many roads lead to Rome." Still persisting in asking him how he would have treated it, Fenger, not to be betrayed again, said, "Listen! you let the attending surgeon in charge of that case treat it the way he wants to."

Fenger, early in his career, served with a battery in the Danish-Prussian War, 1864 (?). His experimental work on bullet wounds and their endoscopy following this experience was so much appreciated that a special grant was made by the Minister of War in order to allow him to continue his experiments in the Franco-Prussian War. Naturally, then, when Pasteur had demonstrated the relation which certain bacteria bore to disease in man, and Lister had demonstrated the possibility of killing or keeping them out of wounds, Fenger quickly saw and accepted the importance of surgical antisepsis and asepsis. In this he was a pioneer. The introduction of Listerian methods in the County Hospital through the influence of Christian Fenger, caused me physical pain, for I was the Junior to whom was delegated the dressing of every open wound or sore. Thus, in the Hospital, all of the leg ulcers, inflamed, ingrowing toe nails, felons et id genus omne, must be dressed under a spray of 5% phenol, washed with 2.5% phenol covered with eight layers of gauze, one layer of mackintosh, and a ninth layer of gauze outside—a useless layer. This meant dressings from 8 a. m. to 6 p. m. daily—and no trained nurses! But soon there began to be healings "per primam," shown at first with pride to the staff and interns and later as something to be expected; finally, if the desired result was not obtained, it was a reproach to someone.

After the first two years as pathologist at Cook County Hospital, he had so thoroughly impressed the staff with his familiarity with surgical problems that the members of the surgical staff left him in charge of their services during vacations. With these opportunities for surgical demonstrations, appointment as attending surgeon soon followed, and for fourteen years he was actively engaged with every kind of surgical problem. During all these years, he constantly accumu-

lated specimens of every type of surgical pathology. Whenever a subject of special interest came up in the societies he would discuss it, submitting abundant specimens in proof of his arguments. These specimens were always at the service of his friends. He frequently helped fill baskets with specimens for his friend, Nicholas Senn, in Milwaukee.

To him, too, the younger surgeons turned hopefully as a sheet anchor in their pathologic difficulties. I recall vividly an acute malignant edema infection in a wound of the thigh severing the quadriceps tendon, which I had sutured 24 hours before. The patient, who had fallen down the hospital shaft, was a protege of the president of the hospital—hence my anxiety. At midnight on a stormy winter night 30 years ago, I rang his doorbell. The little square panel in his door opened. I told him my dilemma. "Wait," said he. He dressed quickly, drove with me to the hospital, saw the patient, and said, "The diagnosis is correct; the infection is now at the midthigh, in the morning it will be above the groin, at noon at the umbilicus, at night he will be dead; do not amputate—you have done everything possible—good night."

Christian Fenger, kindly by nature, never intentionally hurting another's feelings, was nevertheless so bluntly outspoken as to be brusque at times, and chilled friendships that otherwise would have been strong ones. Never politic, when asked for an opinion in a consultation he gave it, without consideration as to what had gone before or the former opinions offered; while the more polished but no more sincere consultant would have glossed over the differences, and accomplished the same good for the patient. The following personal experience illustrates this lack of tact. At a meeting of the Chicago Surgical Society, at which Dr. Fenger presided, I presented my first combined resection of liver and stomach for carcinoma, with patient, specimens and microscopic slides. Before calling for the closing of the discussion, Dr. Fenger arose and said: "I have examined the specimens and the microscopic slides. In these, I note it to be an adenocarcinoma. It is invading the liver tissue without showing a limiting membrane. It will recur within the year with exitus." And the patient was seated directly in front of him! Who knew more about cancer of the stomach than Christian Fenger? His prize essay on "Carcinoma of the Stomach," a classic, was one of the earliest and best descriptions ever written and is never omitted from the bibliography of this subject. To him the world is indebted for the discovery that much of the pain

associated with this ailment is due to the direct invasion of the nerve trunk supply itself by metastatic tumors, specimens of which he submitted with his thesis.

All great men have a hobby, and Fenger's was music. When he desired respite from work he would play on the piano. Accidentally, I learned of his love of music. Many years ago, in the old Exposition Building on the lake front, the opera "Aïda" was given by an all star cast. Campanini, Gerster, Emma Nevada and Scalchi took part. My seat was next to Fenger's. During the intermission, he told me of his service with the Khedive of Egypt who bankrupted the treasury of his country by his extravagances, one of the greatest of which was the ordering of that opera to be composed for him by Verdi for the celebration of the opening of the Suez canal and in honor of the coming of Napoleon III. Carte blanche was given Verdi to secure the best singers in the world. They came from Berlin, Paris, St. Petersburg, Vienna, and London at their own price! No expense was spared in staging the opera in Cairo, the only stipulation being that it should extol the grandeur of Egypt. As an officer in the service of the Khedive, he was provided with an excellent seat at the *première*. Years later in Chicago, the memories of those scenes were again recalled to him vividly and with an evident thrill. Turning to me, he said, "McArthur, I believe the singing and the orchestration equally good, but, oh, the magnificence of the *mise en scène* and the brilliant audience will never be duplicated!"

To one who served at one time as Fenger's house surgeon and later grew up in his environment, after the lapse of two score years the conviction is fixed that Fenger was a great and a learned surgeon. *De mortuis nil nisi bonum* will still permit an ardent admirer and a grateful student to remark: He was not an equally brilliant operator. His exact knowledge of surgical anatomy, his dead-house familiarity with every part of the human body seemed to influence the extent of his incisions. His thorough understanding of the existing pathologic process, his scientific urge to be thorough, would oftentimes prolong an anesthesia to a dangerous length. With his faults (and they were few), we loved him for himself and for what he taught us.

"So when a great man dies,
For years beyond our ken,
The light he leaves behind him lies
Upon the paths of men."

THE EDWIN SMITH PAPYRUS

AN EGYPTIAN MEDICAL TREATISE OF THE SEVENTEENTH
CENTURY BEFORE CHRIST *

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CHICAGO

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In the middle of the twenty-eighth century before Christ the Pharaoh Neferirkere was one day inspecting a new building in course of construction under the superintendence of the chief architect Weshptah. The king and his court were all admiring the work and the Pharaoh was turning with words of praise to his faithful minister, when he suddenly noticed that Weshptah was unable to hear the words of royal favor. The king's exclamation alarmed the courtiers. The stricken minister was quickly carried to the court and the priests and the chief physicians were hurriedly summoned. "His majesty had brought for him a case of writing. . . . They said to his majesty that he was lost." Such are the words of the ancient inscription in which the incident is recorded. The king, smitten with sorrow, can only retire to his chamber in prayer and order sumptuous arrangements for the great man's interment.

The mortuary inscription of Weshptah which thus narrates his death incidentally furnishes us, therefore, the earliest historical reference to medical literature. Unhappily none of the books as old as those which the Pharaoh's physicians consulted on behalf of the dying royal architect has survived to our day. A thousand years after the incident above narrated—that is, at the dawn of the Egyptian Empire or later—the Egyptian physicians endeavored to give authority to the medical literature they used by representing it as having descended from the venerable Pharaohs of even earlier days than those of the dying architect of Neferirkere. The London Medical Papyrus, a worthless compilation of medical magic, informs us: "This book was found in the night, having fallen into the court of the temple in Chemmis (?) as secret knowledge of this goddess (Isis) by the hand of the lector of this temple. Lo! this land was in darkness and the moon shone on every side of this book. It was carried as a marvelous

* Read before a joint meeting of Society of Medical History and the Institute of Medicine of Chicago.

thing to the majesty of King Khufu (Cheops)." Similarly, a section of the Berlin Medical Papyrus claims to have been "found in ancient writings in a chest containing documents under the feet of Anubis at Letopolis in the time of the majesty of King Usephais, deceased; after his death it was brought to the majesty of King Sened, deceased, because of its excellence." If we were to accept these last two statements as historical we should be obliged to conclude that the medical writings of Egypt were some of them produced as far back as the First Dynasty, that is, in the thirty-third or thirty-fourth century before Christ. However this may be, there is no reason to doubt the existence of the medical rolls which were already numerous enough to fill a case in the days of the Pharaoh Neferirkere, in the twenty-eighth century before Christ.

Although we do not today possess any surviving rolls as old as those just mentioned, we have several fragments which belong to the Middle Kingdom (about 2160-1788 B.C.): scanty remains of a treatise on diseases of women, even a veterinary manual on diseases of cattle, and some very important still unpublished fragments, probably the oldest such material known, which will be edited later by Dr. Alan H. Gardiner. The most important medical works surviving from ancient Egypt are a group of four almost or entirely complete treatises of somewhat later date. Two of these are in America and two in Europe: Papyrus Ebers in Leipzig, and the Berlin Medical Papyrus in the National Museum at Berlin; the Hearst Papyrus in the collections of the University of California, and the new Edwin Smith Papyrus, the property of The New York Historical Society. Of these documents the Berlin Papyrus is the latest (about the thirteenth century B.C.), while Ebers, the Edwin Smith Papyrus, and Hearst, are much earlier. Papyrus Ebers dates from the beginnings of the Egyptian Empire in the early part of the sixteenth century B.C., while the script of the Edwin Smith Papyrus would indicate that it is probably slightly earlier, reaching back to 1600 or into the seventeenth century B.C. The New York Historical Society, therefore, is fortunate in possessing the oldest scientific book in America and the oldest nucleus of really scientific medical knowledge in the world. Among historical societies this is a unique distinction. It is gratifying to be able to add, also, the far more weighty fact that the Edwin Smith Papyrus contains incomparably the most important body of medical knowledge which has sur-

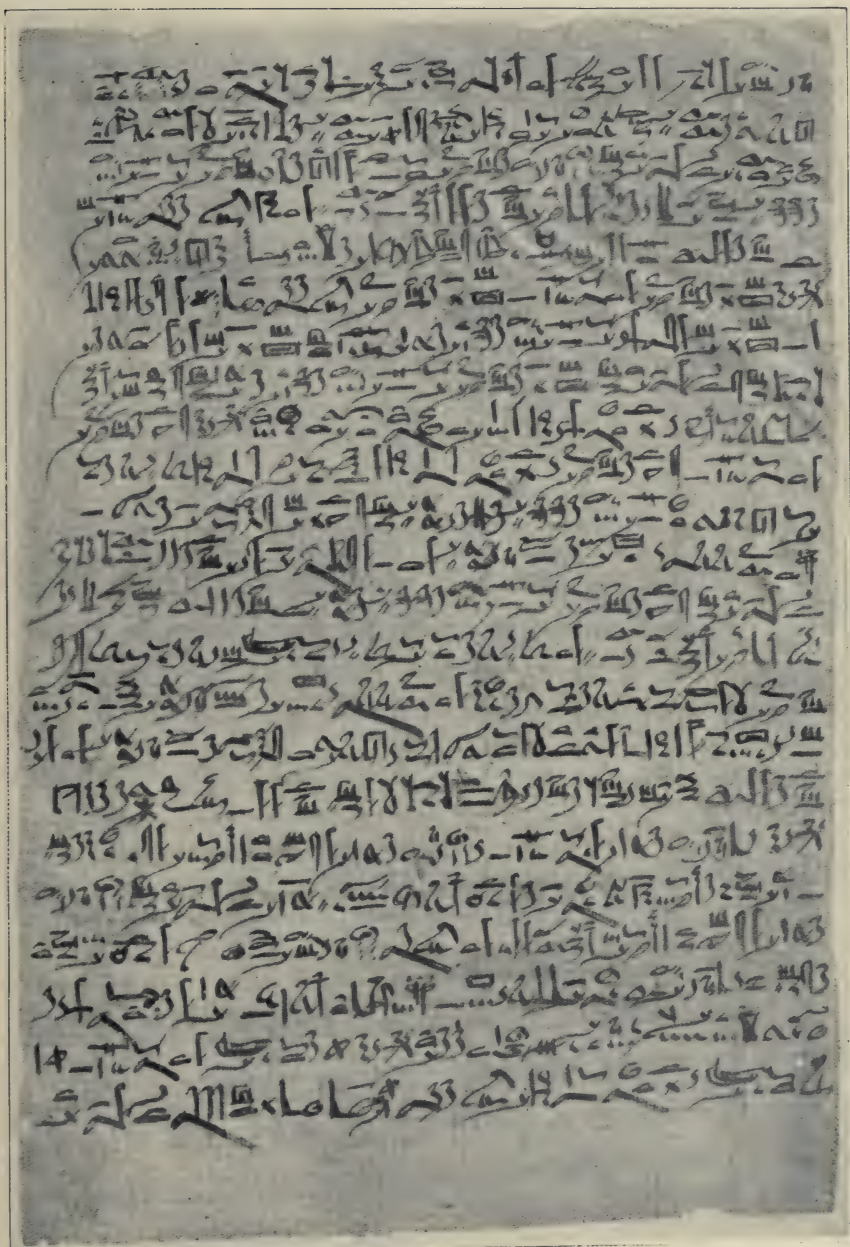


Fig. 1.—A page of the Edwin Smith Papyrus. The writing is the rapid cursive Egyptian hand, called hieratic, in which the original hieroglyphic pictures are abbreviated and rounded off until they have lost their picture form. The manuscript dates probably from the latter part of the 17th century B. C.

vived to us from ancient Egypt, or, for that matter, from the ancient Orient anywhere.

The history of the document is curiously interesting and throws a picturesque light on early oriental studies in America. Mr. Edwin Smith, after whom the document is named, and to whose daughter, Miss Leonora Smith, The New York Historical Society owes the gift of the papyrus, was the son of Mr. Sheldon Smith of Bridgeport, Conn., where he was born on April 27, 1822. The publication in April, 1922, of this preliminary account of the ancient medical document, which he discovered and brought to America, is therefore a very fitting commemoration of the centenary of his birth. His family later removed to Newark, N. J., and thence to New York City, where he was educated at New York University. By a curious coincidence Mr. Smith was born in the very year when Champollion accomplished his decipherment of Egyptian hieroglyphic. His youth thus fell in the years immediately following this epoch-making achievement. This may have been the reason why he early became deeply interested in the study of Egyptology and, after studying the subject in both London and Paris when the science was only a quarter of a century old, he went to Egypt about 1858. He lived in Luxor, ancient Egyptian Thebes, from that time until 1876. Then, after a brief visit in this country, he went to Naples, Italy, where he resided until his death, April 23, 1906. In the early part of 1862, during his stay at Thebes, he purchased the document which is the subject of this article.

I find among Mr. Smith's papers in handwriting so very like that of a note presumably written in the early sixties that it must have been made at about that date, a remarkable attempt at a complete translation of the document. When we remember that the knowledge of hieratic, that is, cursive Egyptian writing, possessed by scholars, and likewise the knowledge of the Egyptian language as a whole, available at so early a stage of Egyptian studies, was very limited, it is extraordinary how much of the document Mr. Smith has understood. He was fully aware of the character of the papyrus as a medical document and had gained a surprising amount of information regarding its content. It must be that during the course of his studies in London and Paris in the fifties of last century, he gained control of all that was known of Egyptian in those early days. We must, therefore, give him a high and honorable place in the history of

oriental studies in America.¹ I would like to mention, also, the fact that of the 8 fragments of the papyrus which, as we shall see, Mr. Smith rescued, he was able to place 3 with entire exactness and 2 more at least in their proper connection. His career in connection with oriental studies and with the discovery of this extraordinary document reminds one throughout of those gifted free lances in English oriental studies, like Goodwin in Egyptian and Rawlinson in cuneiform, who have done so much for the advancement of oriental science. And yet heretofore one would have looked in vain in the annals of oriental research for the name of Edwin Smith. It is eminently fitting, therefore, that henceforth this great monument of ancient oriental science should everywhere be known as the Edwin Smith Papyrus.

The Edwin Smith Papyrus is a roll having, as at present unrolled, a length of 184½ inch. (15 ft. 4½ inch., or 4.68 m.). As at least a column of writing has been lost at the beginning, its original length was demonstrably not less than 196 inch. (16 ft. 4 inch., or 4.97 m.). The papyrus makers of ancient Egypt furnished commercial rolls of conventional length, usually made up by pasting together 20 sheets some 16 inch. (40 cm.) wide, making a total length of the commercial roll about 320 inch. (26 ft. 8 inch.). If our papyrus was of the usual original commercial length,² we have then lost a little over 135 inch., or some 13½ columns. It is written on both sides, 17 columns (377 lines) on the front and 5 columns (92 lines) on the back. At present, therefore, there are preserved on both front and back 22 columns of writing, making a total of 469 lines, or, with the fragments and the additional column demonstrably lost, the document contained at least nearly 500 lines.

The arrangement in columns, made up of horizontal lines, it may be worth while to note, is the origin of the modern printed page. An examination of the two reconstructed rolls in Figure 4 will make this clear. The exposed portion of roll AB is covered with 50 vertical lines of writing numbered from right to left. This was the earlier Egyptian arrangement of a papyrus manuscript. It will be observed that it required no division or interruption in the text. After 2000 B.C.,

¹ See further information regarding Mr. Edwin Smith and his ability to read Egyptian, in the delightful account of the earlier Americans interested in Egyptology, by Dr. Caroline Ransom Williams (Mrs. Grant Williams) in the *Bulletin of the New York Historical Society* (April, 1920).

² Although the full length commercial rolls known to us are somewhat later than the Edwin Smith Papyrus, it is nevertheless highly probable that they were already current in the earlier time.

however, the Egyptian scribes began to write more commonly in horizontal lines, each line necessarily of limited length, so that the writing was divided into columns, as illustrated in the roll CD. In later times, after the rise of the great Alexandrian library, the cumbersome of the roll form of book led to cutting up the roll between these columns into pieces each having one column, and then fastening these pieces together at the edges in piles, thus producing the first cut book pages, of which the columns on the Egyptian rolls were the lineal ancestors.

The Edwin Smith Papyrus was a stately book. The papyrus is 13 inch. high and the columns themselves are between 11 and 12 inch. in height, reaching a maximum of 12 inch. in width, though some are as narrow as 7 inch. It was, therefore, from the Egyptian point of view, of full folio size, a form in which it is paralleled only by the great Papyrus Ebers, all the other medical papyri being a half sheet (about 6 inch.) or less in height. The writing gives us the rapid or cursive form of the originally hieroglyphic signs—a form known since Greek times as hieratic. It is done in a beautiful and regular hand, evidently the work of a skilled scribe, who was, however, unfamiliar with scientific literature. He has a very unhappy time with some unfamiliar words. For example, when he is compelled to draw the human jaw as a graphic “determinative,” he makes a lamentable job of it. But he was evidently very much more than a mere bureau scribe, laboring for the production of merely commercial and other similar records. He made not infrequent mistakes, many of which he has corrected. The corrections are easily discernible because, like all Egyptian scribes, he has written the important introductory words of all his paragraphs and the subsections in red ink, the “rubrics” which passed into later European manuscripts and thus to us. When called on to make a correction, therefore, he did it with red ink over the black writing or with black ink over the red. In one place (column XI) he has omitted an entire phrase, which he has then inserted in the margin at the top of the page, calling attention to its omission by inserting a red cross at the proper place in the text. In some such manuscripts the cross is also appended to the omitted words in the margin, which are to be inserted in the text—thus showing us again where we got our asterisk. This does not happen to be the case in the Smith Papyrus. The entire front of the document is the work of one hand. It is possible, though not probable, that the first

31½ of the 5 columns on the back are likewise the work of the same hand, but the concluding section (columns XXI and XXII) are by a totally different and a later hand.

In taking up the content of the new papyrus we cannot avoid referring to the present limited state of our ability to deal with such a document and determine its content. Let the average man of today sit down to read a technical description of an automobile engine. He will undoubtedly find himself confronted in every line by at least one word of which he does not know the meaning—and this in twentieth century English! I recently sat at a dinner table where not a person present knew the meaning of the word “gasket.” If such is our predicament when dealing with a highly specialized word in our own contemporary mother tongue, how much greater must be the difficulty when we are confronted by a body of specialized words, employed by the medical men of 3,500 years ago, writing a language which has now been dead for centuries. Our difficulty is increased by the fact that no one has ever yet carefully studied the medical documents of Egypt together as a group, or built up a carefully grounded glossary of the medical terms which they contain. So-called translations of the Papyrus Ebers have been made, with misunderstandings on every page which make them ludicrous, and much popular writing based on such translations has professed to give us some account of Egyptian medicine. Such a discussion is of course not only without value, but very misleading. On the other hand, Professor Wreszinski of Koenigsberg before the war had begun a series of preliminary publications of the available ancient treatises, together with concordances, and these initial studies are of the greatest value. Unhappily they have been suspended by the war. Useful studies of particular points or passages have been made by Schaefer, Erman, Maspero and others, and from the practical physician’s point of view also by von Oefele. But a thoroughgoing study of the whole subject, based on all the surviving treatises, still remains to be made. We should have exhaustive studies especially of all pathologic, physiologic, anatomic, mineralogic and botanical terms appearing in these documents. Even when this has been done, there will be many words in these ancient treatises which we do not understand and many phrases which we cannot render. There are many such in the Edwin Smith Papyrus which I do not yet comprehend,³ and that will undoubtedly be the case

³ It is needless to say that the present writer possesses no more than the average layman’s knowledge of anatomy.

when the final manuscript for the publication in extenso is ready. Another difficulty lies in the complete lack of any comparative study of these ancient medical books, or the symptoms and diseases which they describe, on the one hand, and on the other the surviving evidences of disease in the ancient bodies excavated by the thousands in the Egyptian cemeteries and studied with such success by Dr. G. Elliot Smith and others. I have inserted in this preliminary report on the new papyrus a few examples of these ancient bodies, to illustrate this side of the unexplored field. In reading the following account of the content of this new medical papyrus, then, the reader should bear in mind these fundamental difficulties which hamper our understanding of a treatise so specialized and so ancient. It may be remarked also that the treatise itself throws most interesting light on the meanings of some of the terms it employs, and persistent study discloses such unexpected revelations as the bit of fascinating ancient anatomic description—the oldest such description known—of the articulation of the human mandible with the temporal bone, as we find it in this venerable medical book.

The Edwin Smith Papyrus obviously falls into 3 different parts, drawn from 3 different sources.

1. The seventeen columns of the front.
2. The "Incantation of Expelling the Wind of the Year of Pest" (three and one-half columns of the back).
3. The "Incantation of Transforming an Old Man into a Youth of Twenty" (part of the last two columns of the back, XXI and XXII).

The second and third, mysteriously attractive as they may seem to be, are brief magical treatises. The second is made up solely of magic incantations, interesting as already containing the widely prevalent notion which has persisted even into our own day, that malignant plagues are carried by pestilential winds. It is possibly by the same hand as the front, the slight differences being caused by the difference in the direction of the fibers of the papyrus (horizontal on the front, vertical on the back). The last section was copied from some old source in a hand totally different from the other two treatises, as we have noted, by a later scribe who could not resist its attractions.

It is the seventeen columns of the front which make the Edwin Smith Papyrus unique. They contain part of an extraordinary ancient

book of surgery and external medicine which began its discussions with the top of the human head and proceeded in orderly progression downward to the lower members, presumably concluding with the feet. Though the divisions are not indicated by the ancient scribe, this treatise on the front falls into the following sections, represented by 48 cases :

1. Head (Calvaria) (Cases 1-10).
2. Nose (Cases 11-17).
3. Mandible, ear and lips (Cases 18-27).
4. Throat and neck (cervical vertebrae) (Cases 28-33).
5. Collar bone and shoulders (clavicle and scapula) (Cases 34-38).
6. Thorax and mammae (Cases 39-47).
7. Spine (Case 48, incomplete).

Unhappily the scribe who copied the original treatise suddenly stopped at the bottom of column XVII in the middle of a line and in the middle of a sentence, leaving blank at the end of the roll an entire sheet (16 inch.) of papyrus and cutting off the original treatise in the midst of the first case devoted to the spine. Stopping thus he has left us without any of the treatment of the human body below the thorax except the beginning of one case on the spine. When he, or possibly another copyist, resumed his work he turned the roll over and began to copy on the back the worthless incantations of the second part already mentioned. We should be grateful, however, for what the ancient scribe has done for us, for these 17 columns contain the most carefully made and most systematically arranged observations on the human body and its ailments which have thus far survived from an age so remote.

Each of the 48 cases is methodically arranged thus :

- (a) Title, always beginning: "Instructions for . . ." (name of ailment).
- (b) Examination, always beginning: "If you examine a man having . . ." (symptoms follow).
- (c) Diagnosis, always beginning: "You should say concerning him: 'A sufferer with . . .'" (name of trouble follows).

(d) Verdict,⁴ always one of three:

1. "An ailment I will treat." (favorable)
2. "An ailment I will contend with." (doubtful)
3. "An ailment I will not treat."⁵ (unfavorable)

(e) Treatment.

(f) Explanatory glosses (seventy in all).

The first group (10 cases, 1-10) deals with wounds in the head, of which the first 7 are knife or sword wounds penetrating to the bone.⁶ They vary in character according as the skull itself escapes injury or suffers contusion, a gash, a fracture, etc. In all these cases the surgeon is instructed in the examination: "You should probe the wound." If he finds only a contusion of the skull or no injury at all, the verdict is favorable; a gash in the skull, doubtful; a fracture in the skull (several kinds), unfavorable. Case 7, which occupies over 2 columns and is the longest case in the treatise, describes 3 different conditions of the injury to the skull under the knife wound, gives two verdicts (one doubtful, one unfavorable), and in the third condition says to the surgeon: "You should have made for him a wooden brace padded with linen, (and have) the head fastened to it . . . His treatment should be sitting, placed between two supports of brick, until you know whether he is making any progress." These contrivances are evidently devices familiar enough to the Egyptian practitioner to need no further description. The first might be variously explained but the second, built of sun-dried brick like the beds of the poor, is obviously intended to prevent the sufferer from lying down and disturbing a badly injured skull. It may be mentioned also that the examination in this case notes a feeble pulse and fever as among the symptoms. That the Egyptian surgeons had plenty of such cases to deal with is interestingly illustrated by the gashed skulls shown in the illustrations. The healed sword-cut illustrates the surgeon's ability to deal successfully with such injuries.

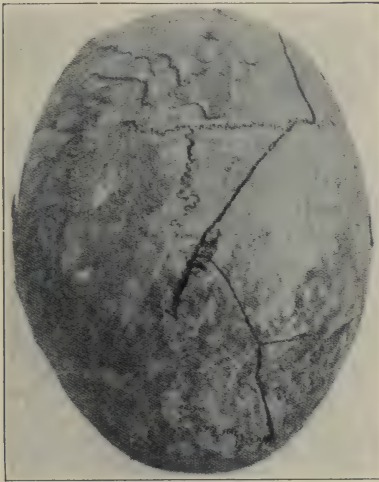
Case 8 deals with a "fracture of the skull under the skin." When examination has demonstrated the presence of the fracture, the surgeon is unconditionally charged to operate, to open at the point of contusion,

⁴ Some such term (not drawn from the original) seems preferable to our modern "prognosis," which does not exactly correspond.

⁵ Grammatically, this phrase is not clear in the original; but the character of the cases to which it is appended, and the wording of the phrase, make it clear that it characterizes a case as probably beyond the physician's power to treat successfully. For example, see case 33, a crushed cervical vertebra, and compare the case of the architect Weshtah, which the physicians pronounced hopeless.

⁶ These wounds might also be due to the long-bladed Egyptian war axe of the Middle Kingdom.

and "to elevate the depression outward." It may be for the modern surgeon to decide whether this could be done without trephining; if trephining is involved, as would seem probable, we have here the earliest reference in literature to this famous operation. Although an operation known to have been practiced by peoples in a primitive state of culture, trephining has not yet been unmistakably identified on surviving ancient Egyptian skulls. In any case, the proposed operation was a desperate measure. The verdict was unfavorable, recovery doubtful and the patient was to be treated sitting up, as in Case 7.



Figs. 2 and 3.—Sword cuts in Egyptian skulls of a century or two before the Christian era. In Fig. 5 (left) the cut and the resulting fracture caused death; in Fig. 6 (right) the art of the surgeon healed the wound and the man survived. (From G. Elliott Smith and F. Wood Jones.) *The Archaeological Survey of Nubia*. (Report for 1907-1908.) Vol. II. *The Human Remains*, pl. XLI, Fig. 3, and pl. XLIII, Fig. 2.)

In the last two cases of this group (9 and 10) the treatise proceeds to the front of the skull: a knife wound in the forehead with fracture and a wound through an eyebrow. The cut in the forehead is to receive a plaster made of "physicians' skin"—a kind of linen bandage prepared by the embalmer; the cut in the eyebrow is to be carefully held together by a special "double bandage" so as to "cause the two lips of the knife wound to join one to the other."

A second group of 7 cases (11-17) deals with the nose and connected trouble: an uncertain affection in the "column. (upper part) of

the nose," the same in the "inaccessible region of the nose," "fracture in the nose," a "wound in the nose" which penetrates to its interior, and so on. In treating the trouble in "the inaccessible region of the nose" the secretions are to be cleared away by using "two swabs of linen" and thereupon "two rolls of linen dipped in ointment" are placed in the nostrils. The affected region is defined in the gloss as "the middle of the nose as far as the back, penetrating to the region between the two eyebrows"—a description which might be an effort to define the frontal sinus region. Curiously enough the next case—"fracture in the nose"—is given an unfavorable verdict, perhaps due to the unfavorable Egyptian climate, and no treatment is suggested.

The treatise now proceeds from the nose to the maxillary region, extending to the ear at one end and the lips at the other end, and adding also the mandible. All the troubles discussed seem to be wounds and not diseases. Five of the 10 cases are wounds in the *gema'* (*gm'*), which the ancient surgeon explains in a gloss is "between the orbit (?) of the eye and the orifice (?) of the ear at the back of the jaw." Explaining the relations of the bones in this region he says in another gloss that a thing he calls the *'am 'et* is the "back part of the jaw," meaning, of course, the ramus. He adds the interesting remark: "The back of the *'am 'et* (ramus) is in the *gema'*, as the claw of an *'am 'e-bird* is thrust into a thing." It is evident that the ancient surgeon is likening the 2 fork-like projections on the top of the ramus (the coronoid process and the condyle) to the claws of some two-toed bird,⁷ and the *gema'*, into which this two-toed claw is thrust, is, of course, the temporal bone. We should here observe that the ancient anatomist not only noticed the resemblance of the ramus, with its claw-like fork at the top, to the claw of the bird and found it useful in his description, but also evidently drew his name for the bone from the name of the bird, thus furnishing, I believe, the earliest known example of this particular kind of terminology-building, later, and still, very common. The identity of the *gema'* is again revealed in a gloss on Case 7 in which our ancient writer says "the ligaments back of the *'am 'et* (ramus) are fastened to the *gema'* (temporal bone) back of the jaw." As every physician knows, the temporal muscle which operates the mandible is anchored on the temporal bone and attached to the anterior fork of the ramus (the coronoid process). Among the

⁷ If I am correctly informed, the ostrich is the only two-toed bird. The word here used is not the customary word for ostrich in Egyptian.

5 cases (18-22) of trouble with the gema' (temporal bone) it is of great interest to note the surgeon's observation of complications both in the ear and in the eye. A glance gem' = temporal bone and 'am 'et = ramus shows the layman in these matters how close are these bones to the orifice of the ear—a commonplace fact to the physician. The last of these 5 gem' cases is a fracture of the gem'; the observer notes that the patient suffers from deafness, and the surgeon is directed to clean out the ear on the affected side with a swab of linen in order to be able to see the "absorption" (?), explained in a gloss as "absorption (?) of bone tissue in the inside of the ear." This examination is in spite of the fact that the surgeon's verdict is unfavorable and that no treatment is suggested.

Two cases of trouble in the mandible are not wholly clear. Their occurrence in the treatise, however, reminds us of the extraordinary evidence in the Harvard mandible of the surgeon's skill in tapping and draining an ulcer deeply buried in the alveolar process (Fig. 9). In a case of dislocated jaw the practitioner is told how to place his hands in order to force the dislocated bones back into place.

The treatise devotes 27 cases to the head and then proceeds lower. The fourth group of cases (28-33, six in number) concern the throat and neck (cervical vertebrae). The first is a serious case of "a man having a knife wound in his throat, penetrating to his gullet; if he drinks water it turns aside, issuing from the mouth of his wound, and he is very hot and develops fever from it." Strangely enough, the physician seems to worry less about this case than about others which would seem to us less serious.

The remaining 5 cases concerning the vertebrae of the neck (29-33) again display the surgeon's desire to render his terms precise. One of these deals with a "wenekh of the vertebra of the neck." The patient loses control of arms and legs and the excretory organs and the physician gives him up. It is interesting in this connection to recall that the physicians of the Pharaoh pronounced the architect Weshptah's case hopeless. Nevertheless, although no treatment is suggested or intended, the surgeon appends an explanation for each of 3 important matters arising in the discussion of this hopeless case. The first of these is a gloss on the name of the case. It reads: "Concerning: 'a wenekh in the vertebra of the neck'—it means between one vertebra of the neck and the next one, the flesh which is upon it being whole; as one

says 'wenekh' concerning things which had been joined, when one is broken from another." It is obvious that a dislocation of the neck is meant.

Among the mechanics employed on the great building of Egypt, like the pyramids and temples, there must have been many such case. A single excavation campaign, which exhumed between 5,000 and 6,000 bodies, disclosed one person with a fractured bone among every 32 people. The last of the 5 cases of trouble in the cervical vertebrae is called "sehem in the vertebra of the neck" (Case 33). The patient is deaf and speechless and has lost all control of arms and legs. The physician at once pronounces the unfavorable (third) verdict and offers no treatment, but displays his further purely scientific interest in the case by adding 2 glosses: "Concerning: 'a sehem in the vertebra of the neck;' it means one vertebra of his neck has been depressed into the next, one penetrating into the other and not assuming any carrying" (meaning, of the weight above). The second gloss explains that this has happened because the injured man "has fallen head downward on his head, driving one vertebra of his neck into the next." From other sources we know that the word sehem means "crush" and was not an uncommon word, but the scientific interest of the ancient surgeon does not allow him to leave the case merely as that of a broken neck, designated by a common word; he desires to explain what happened.

The same purely scientific interest is displayed in discussing the very next case, which opens the next group, consisting of 5 cases (34-38) devoted to the collar bone and shoulder (clavicle and scapula). In speaking of the flesh over the collar bones and thorax the ancient writer casually adds: "There are two canals under it: one on the right and one on the left of his neck. They lead to the lungs"—a fact which evidently interested him though it had no necessary bearing on the case. The operations for a dislocated clavicle and scapula are both described. In both the patient is laid out on his back and to repair the shoulder the arms are spread out "in order to stretch out the shoulder until the dislocation falls into its place."

The sixth group contains 9 cases (39-47) concerned with the thorax. Among these it may be that one is cancer, a disease already designated as karkinoma in the late Christian documents of Egypt, as affecting the breast of a woman. All the patients in our papyrus, however, are men.

With the forty-eighth and last case the treatise passed to a seventh group, cases of the spine. The trouble affects one of the vertebrae of the back. The patient suffers pain in moving his legs. The practitioner is instructed: "He should place him prostrate and make for him " We shall never know what interesting operation followed, for at this point the ancient copyist stopped in the middle of a sentence, and, as we have already noted, when he resumed copying on the back he no longer had before him the great lost medical book of which he has given us such an extraordinary glimpse. Among Mr. Smith's papers I find a sympathetic echo of the same disappointment which I felt myself on reaching this point in the document. Referring to this point Mr. Smith says: "Here ends abruptly the face of the papyrus; on the back we find 5 more pages, the work of two different hands, and the first part mere magical bosh—with five receipts of not much value."

I have intentionally given little or no attention in the foregoing brief discussion to the scanty therapeutic, a matter in which the treatise is, on the whole, not strong. In the healing of wounds and bruises the ancient physician's favorite application was fresh meat, followed after the first day by ointment of honey and an astringent herb. The complete materia medica of the document would make a surprisingly brief and simple list. The attitude of the physician is distinctly that of cooperation with nature. Repeatedly he directs the practitioner to undertake no treatment but to put the patient on normal diet and await results. This is an extraordinarily sane point of view in such an age. It should be noted also that many of these cases are solved by operation and only afterward, or not at all, by medicaments. If a man has a dislocated jaw which the surgeon has succeeded in forcing back into place, he is only to apply a simple ointment by way of soothing the soreness afterward.

The most valuable body of material in the work is the group of 70 explanations, which we have called glosses—definitions of terms contained in the discussions of the cases. Their character has already been illustrated. They are encountered at the very beginning of the preserved portion of our document and it is with the deepest regret that one finds, in mutilated condition among the fragments preceding the first well preserved column of text, a long gloss containing an account of the heart and its system of canals and vessels. This statement is, in part, a duplicate of a similar account in the Papyrus Ebers.

but in the Edwin Smith roll it is longer. It makes continual use of the word "count," suggesting that the counting of the pulses of the heart is meant, but I have not yet been able to make this conjecture a certainty. We have here the famous passage, likewise found in Ebers: "There is in it (the heart) a canal leading to every member of the body. Concerning these—if the physician . . . places the fingers on the back of the head, on the hands, on the pulse, on the legs, he discovers the heart, for the heart leads to every member and . . . it beats (literally 'speaks') in the canals of every member." In our document this extraordinary account of the heart as the center of a system, throughout which its pulsations are felt, forms an explanatory gloss appended to a case of a wound in the head—apparently in the effort to account for disturbances carried throughout the body, though resulting from the seemingly local trouble in the head. This effort to reach a scientific explanation of the observed conditions illustrates the physician's interest in the scientific aspects of his subject, which we find throughout this venerable document.

Sometimes, however, these explanatory glosses display simply a desire for greater precision. Thus in Case 8, dealing with a fracture of the skull under the skin, we have the following gloss:

"Concerning: 'a fracture in the skull under the skin of the head without there being any wound upon it';—it means: a fracture of the shell of the skull, the flesh of the head being whole."

In dealing with the case of the gash in the eyebrow we have a gloss in explanation of the bandages which reads: "Concerning: 'the two 'awy of linen';—it means: two bandages of linen. Let them be applied on the two lips of the knife wound, in order to cause that one join to the other."

The question at once arises: why were not these more precise data included in the original discussion of the case, rather than appended as a seeming afterthought? It is quite evident that the original discussion was an inherited text which, if not canonical, was sufficiently respected so that it was not to be altered by such insertions. The medical rolls of the royal physicians, brought in at the architect Weshptah's death, which we recalled at the beginning of this paper, were just about a thousand years old when our copyist was making the Edwin Smith roll. Such a text, already a thousand years old, would of course contain obsolete words requiring explanation. For

example, in Case 8 some later reader of the old document has felt it necessary to explain the injunction to operate, as follows:

"Concerning: 'the seken of the depression outward, on the side of him having this hurt';—it means: pressing the depression outward on the side of him having this hurt." It happens that another case employing the word *seken*, twice substitutes for it the variant "elevation." The present writer thus incidentally learned that the ancient word *seken* means "elevation" both as verb and noun. But even the old Egyptian reader found that the word was no longer familiar and needed definition.

Besides such obsolete words there were also old idioms which had fallen into disuse and needed explanation. We find a very interesting example often appearing in cases in which the physician waives any treatment but gives the practitioner the following instructions, which, literally translated, mean: "Put him on his fingers," or, even more curiously in a frequent variant, "moor him on his fingers." Even to the Egyptian reader of the Edwin Smith Papyrus in the seventeenth century B.C. this mysterious admonition was enigmatic. The commentator therefore supplied a gloss, reading: "Concerning: 'moor him on his fingers';—it means: to put him on his accustomed food without giving him medical treatment." This sound and conservative policy is very often recommended by the ancient physician. How it might have been possible for so grotesque an injunction as "moor him on his fingers" to come to mean "put him on his accustomed food," there is not space here to conjecture; but it may be mentioned that the ancient oriental of course ate with his fingers, and the line of connection between the curious idiom and its meaning is perhaps to be found in this custom. The student of English 5,000 years hence will doubtless find phrases about food, like "grub-stake," quite as puzzling as the curious old idiom of this medical document.

Our copyist undoubtedly found already appended to the text these explanations of the quaint or no longer intelligible words and phrases of his ancient ancestors. For these glosses are in the language of the Middle Kingdom, a period several centuries earlier than our papyrus. Our copyist was not himself a medical man, while the glosses are obviously the work of a closely observant physician. It is worth while noting that in one of these glosses we have a hint that he has not always preserved the complete text of the ancient book he was endeavoring to explain. The glosses are always quite clear in their

arrangement, introducing the phrase to be explained by the word "concerning" following which there is, therefore, a verbatim quotation from the original discussion. In the gloss on the word *seken* already noted, we find at the end of the phrase to be explained the following words: "on the side of him having the hurt." Now these words are not in the original discussion as it is preserved in the Edwin Smith Papyrus and they indicate that the trouble was on one side of the skull, a circumstance not elsewhere mentioned in the discussion of the case. Hence the sudden appearance of this new item in the gloss suggests that the medical book which the commentator had before him had a fuller text. It is possible, therefore, that the original ancient text out of which the glosses have grown has not always been reproduced in full. This conclusion would explain the brevity with which surgical devices obviously needing some further description are merely mentioned by name.

The reader is now in a better position for making a general estimate of these 17 columns of the front. We have here in 377 lines 48 systematically organized cases, chiefly surgical, discussing especially the bony framework of the body from the braincase downward to the thorax and the vertebrae below the cervical group. These discussions form the torso of a great lost medical book on surgery and external medicine already so old in about 1600 B.C. that commentaries on many terms and phrases had long before become necessary. This commentary, made up of 70 glosses, may already have been several centuries old when copied into the Edwin Smith Papyrus.

In bulk even this torso of the ancient book considerably exceeds the other leading medical papyri: Ebers, Hearst and Berlin. Hearst has 273 lines (and a few small fragments), while the Berlin Papyrus has 280. Both are about 100 lines shorter than the front of the Edwin Smith Papyrus alone. The stately Ebers papyrus, with its 110 columns of text, 875 recipes, and a total of 2,289 lines, although much larger, has only about 250 lines of material which can be compared with the cases in the Edwin Smith Papyrus.

In method and character the old "Book on Surgery and External Medicine" is far superior to these other 3 rolls on which we have heretofore based our estimate of ancient Egyptian medical knowledge. It is important to make this fact evident. All of the 3 papyri just mentioned, not excluding the great Papyrus Ebers, are merely haphazard collections of recipes mingled in an indescribably confused

hodgepodge; whereas our old "Book on Surgery and External Medicine" is a systematic organization and discussion of cases. While we have long known, especially from the Ebers Papyrus, that the Egyptian physicians made diagnoses, yet out of the 875 recipes in Ebers only 47 are accompanied by a diagnosis of the ailment to be cured; and of these only a group of 21 unfortunately very limited cases of boils and the like, at the end of Papyrus Ebers, can be compared in care and system with those in the Edwin Smith Papyrus. The other 2 important medical papyri contain fewer diagnoses than Ebers. The Berlin roll has only 2; and the Hearst Papyrus only 1, a very meager diagnosis of rheumatoid trouble in fingers and toes.

The same contrast is observable in the matter of systematic classification of cases by a verdict following the diagnosis. No other medical papyrus contains this system, which we find so carefully employed in the Edwin Smith roll, classifying all cases by appending one of three verdicts: favorable, doubtful, unfavorable. The third verdict is not found in any other document. The second verdict is known elsewhere only in Ebers, where it occurs twice, and the first verdict, applying to easy cases requiring simple treatment, is found sixteen times in Ebers, twice in the Berlin Papyrus, and once in Papyrus Hearst.

As for the commentary, it is found in the other medical documents of Egypt only in the Ebers Papyrus, which contains 26 glosses, not systematically following the cases to be explained, but in 2 disconnected groups which the ancient scribe, having disarranged his papers, has intruded into irrelevant discussions. To sum up this comparison, then, the other leading medical documents of ancient Egypt (Ebers, Berlin and Hearst) are each a hodgepodge of miscellaneous recipes dominated by magic from beginning to end, while the old "Book of Surgery and External Medicine," partly preserved in the Edwin Smith Papyrus, appears by contrast as a unique organization of cases containing especially in examinations, diagnoses, verdicts and glosses, more scientific medical discussion and indeed in the glosses 250% more commentary material than all the other surviving ancient Egyptian medical documents combined. We have, therefore, in the Edwin Smith Medical Papyrus, as we stated at the beginning, obviously the most extensive and important surviving source for our modern knowledge of ancient Egyptian medical science. Among the earliest known monuments in the whole range of ancient investigative science it stands easily first, to

be compared only with the famous Rhind Mathematical Papyrus in the British Museum, a book of nearly the same age.

Incomplete though it is, this torso of the ancient Book of Surgery and External Medicine preserved in the Edwin Smith roll offers enough to enable us for the first time to form a just estimate of the character and value of Egyptian medical knowledge. Each of these 48 cases is, as we have seen, identified by a list of objective conditions carefully observed—conditions often due to wounds or accident. The latter cases, due to physical causes quite clear to the physician, obviously have no connection with the activities of malignant demons of disease. Thus these cases of organs and tissues injured by intelligible physical agencies form a realm quite uninvaded by magic powers—a realm in which the Egyptian physician gathered the observable facts of anatomy, physiology, surgery, and therapeutics, quite unbiased by his inherited traditions regarding the demoniacal causes of disease.

In these 48 cases of the Edwin Smith Papyrus only one mentions or makes any use of a magic charm, and it is evidently not an accident that this case which resorts to a charm is also the only one which lacks any verdict. The physician evidently excluded it from his list of cases to be treated by other than magical means. We have here, then, a group of the earliest recorded observations in natural science made by man. Here was a realm in which the physician was confronted often enough, to be sure, by the unknown, but not by the demoniacal. Here was the physician's exclusive realm, to be dealt with by the physician's skill. He knew it and recognized it and applied to it the phrase "art of the physician," as he repeatedly calls it in contrast with the "art of incantations,"^{*} applied to ailments arising from demoniacal causes. The current view, that in all cases Egyptian medical practice invariably employed magic devices, a view in which I formerly also shared, is quite evidently wrong. There was, indeed, surviving from primitive times a large body of traditional practices in medical treatment wholly or chiefly magical which never disappeared. Such practices, universally and implicitly followed by the common people, forming what we may call "demoniacal medicine," always had its devotees, the descendants of the old "medicine men," with their rolls of ancient hocus-pocus, like the medical papyrus of the British Museum, or the "Charms for

^{*} Without any seeming connection with the text the phrases "the art of the physician" or "the art of incantations" are to be found abruptly intruded into the prescriptions in the medical documents. It seems to me highly probable that there is an effort here to distinguish the two different agencies which the physician may apply.

Mother and Child" in the other well-known roll, at Berlin. Such primitive superstition dies hard. It lasted far down into the history of our own land. Increase Mather, President of Harvard University, in his treatise on "Remarkable Providences," insists that the smell of herbs alarms the devil and that medicine expels him. Such beliefs have probably even now not wholly disappeared from among us. We cannot wonder that this was the almost universal point of view in the early world with which we are dealing.

These essentially magical rolls, however, to which we have just referred, occasionally absorbed something of the growing medical knowledge other than the demoniacal. A very little of this leaven crept into Papyrus Hearst, more into the Berlin roll, and yet more into the famous Papyrus Ebers. But even so, the Papyrus Ebers remains a mere hodgepodge of recipes and all the treatises mentioned here were the working tools of superstitious practitioners of demoniacal medicine, who were no more truly representative of the best medical knowledge of the time than are the chiropractors, faith-healers, and innumerable other untrained quacks of our own day. The author of the great Book of Surgery and External Medicine, of which we have a mere fragment on the front of the Edwin Smith roll, was one of a group of men who will likewise inevitably have been children of their time. We cannot conceive that they ever ceased to believe in the power of magic; but they had learned that in surgery and medicine they were confronted by a great body of observable phenomena, which they systematically and scientifically collected, sometimes out of interest in the salvation of the patient, sometimes out of pure interest in the scientific truth. The class of men thus revealed to us are the earliest natural scientists of whom we know anything, who, confronting a world of objective phenomena, made and organized their observations and based inductive conclusions on bodies of observed fact. It is important to emphasize here the fact that these men evidently practiced dissection of the human body, a method of investigation in which Greek medicine, 1500 years later, was noticeably weak.

The current conclusion regarding the mind of the ancient Egyptian, a conclusion in which I have myself heretofore shared, has been that he was interested in scientific principles, if at all, solely because of the unavoidable necessity of applying them in practical life; that if he discussed the superficial content of a many-sided geometrical figure or the cubical content of a hemisphere it was because he was obliged

to measure fields for taxation purposes and to compute the content of granaries. In the field of Egyptian mathematics Professor Karpinski of the University of Michigan has long insisted that the surviving mathematical papyri clearly demonstrate the Egyptians' scientific interest in pure mathematics for its own sake. I have now no doubt that Professor Karpinski is right, for the evidence of interest in pure science, as such, is perfectly conclusive in the Edwin Smith Medical Papyrus.

While it is now quite evident that the treatises of the greatest physicians of ancient Egypt have not survived in the available medical rolls, we should notice that even the Edwin Smith Medical Papyrus, taken as a whole, is a compilation from 3 sources, 2 of which contained the commonest magical rubbish. As we have seen, however, the compiling copyist had access to one of the earlier great medical books, a stately roll of many columns. He doubtless began at the beginning of the fine old roll before him and, perhaps laying down a new unwritten roll of nearly 27 feet in length, he copied the earlier sections of the great work on Surgery and External Medicine. That filled the front side of his new roll, or carried him to its last sheet, where he left a sufficient margin of space to insure the safety of the last column and prevent it from being frayed or torn. We shall never know what occasioned the interruption after the front of the new roll was filled up. We can hardly suppose that the mere act of turning to the back of the roll could in itself have been the occasion which led the hack copyist to turn away from his great Book of Surgery and External Medicine to another roll which he had at hand—a superstitious mess of incantations, with which he, or possibly some other copyist, then began to encumber the back of our roll.

He was working for some quack who wanted nothing better than a fine line of magical wares with which to ply his daily calling in a superstitious age. This first owner of our roll was probably a little practitioner in one of the perhaps suburban villages on the fringes of the magnificent imperial capital of Egypt at Thebes. Eventually he handed on the roll to some later worthy in the same craft. The last owner was much attracted by a book containing recipes for “transforming an old man into a youth of twenty” and he took pains to copy these at the end of the older material collected by his predecessors. In the meantime, much handling and daily use of the document had frayed the beginning of the roll, and case after case of the fine old

Book of Surgery and External Medicine dropped off in tatters. When at last the village quack himself fell sick and found his art unable to exorcise the demons of disease, his surviving relatives carried him up and laid him away in a rock tomb in the great Theban cemetery. Luckily for us, they laid his roll in his coffin with him; and it reposed in perfect safety throughout the vast sweep of human history for some three and a half millenniums from the migrations of the Hebrew patriarchs and the prehistoric wanderings of the Greek barbarians to the American Civil War. The modern descendants of the old Egyptian quack, searching the tombs for salable plunder, found the roll beside the body of their Theban ancestor and saw in it prospects of gain. They stripped off its tatters of papyrus still hanging on the outside, to make it look more "ship-shape." After selling this roll to Mr. Edwin Smith in January, 1862, they patched up another out of indiscriminate rubbish and gave it the appearance of a papyrus roll by wrapping around it and gluing in place the tattered fragments which they had stripped off the genuine roll. Two months after the first sale they put this dummy roll also on the market and sold it, likewise, to Mr. Smith. Detecting the fraud, Mr. Smith recognized and rescued the new fragments of the precious medical book, thus recovering for science the extraordinary, even though fragmentary, discussion of the heart and its system of canals, to which we have already referred.

Such is the new chapter in the history of American Egyptology, begun two generations ago by the work of Mr. Edwin Smith. The papyrus which so appropriately bears his name has revealed to us furthermore a new chapter in the history of science. We have now at least an intimation of the character of the medical knowledge and practice of the great royal physicians at the Pharaoh's court in the days of the Hebrew patriarchs. These men, the leading scientists of their day, the earliest observers in natural science, and the first men to dissect the human body are thus known to us only in a later, incomplete copy of one of their books. May it some day be our good fortune to find lying in the tomb of such a royal physician the complete Book of Surgery and External Medicine from which the front of the Edwin Smith Papyrus was copied!

ANNOUNCEMENTS

Since Jan. 1, 1922, the following have been elected fellows of the Institute:

Chas. A. Parker
McMicken Hanchett
Edward A. Oliver
Ernest L. McEwen

Walter F. Winholt
Ellison L. Ross
Thomas E. Roberts
Lester R. Dragstedt

The next Pasteur Lecture will be given by Dr. Jacques Loeb of the Rockefeller Institute for Medical Research in New York.

May 10 an informal dinner was given at the University Club to Sir Thomas Lewis, who gave an illustrated lecture on the action of quinidine on auricular fibrillation.

The Board of Governors has appointed a special committee on the Medical Needs of Chicago, and subcommittees have been designated to report on otology, orthopedics, medical jurisprudence, mental hygiene, hospitals, pediatrics, oral pathology and hygiene, rehabilitation.

The joint meeting of the Institute with the Chicago Surgical Society, February 3, was addressed by Dr. C. L. Starr of Toronto; the joint meeting with the Chicago Ophthalmological Society, April 21, was addressed by Professor E. Fuchs of Vienna on ocular manifestations of internal secretions; at the joint meeting with the Society of Medical History, May 12, Professor J. H. Breasted of the University of Chicago read a paper on the Edwin Smith Papyrus, an Egyptian medical treatise of the seventeenth century before Christ.

STORAGE



